PRICE $2.00

HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATHKIT®
ASSEMBLY MANUAL

HEATHKIT

SOLID STATE 5" OSCILLOSCOPE
MODEL IO-102

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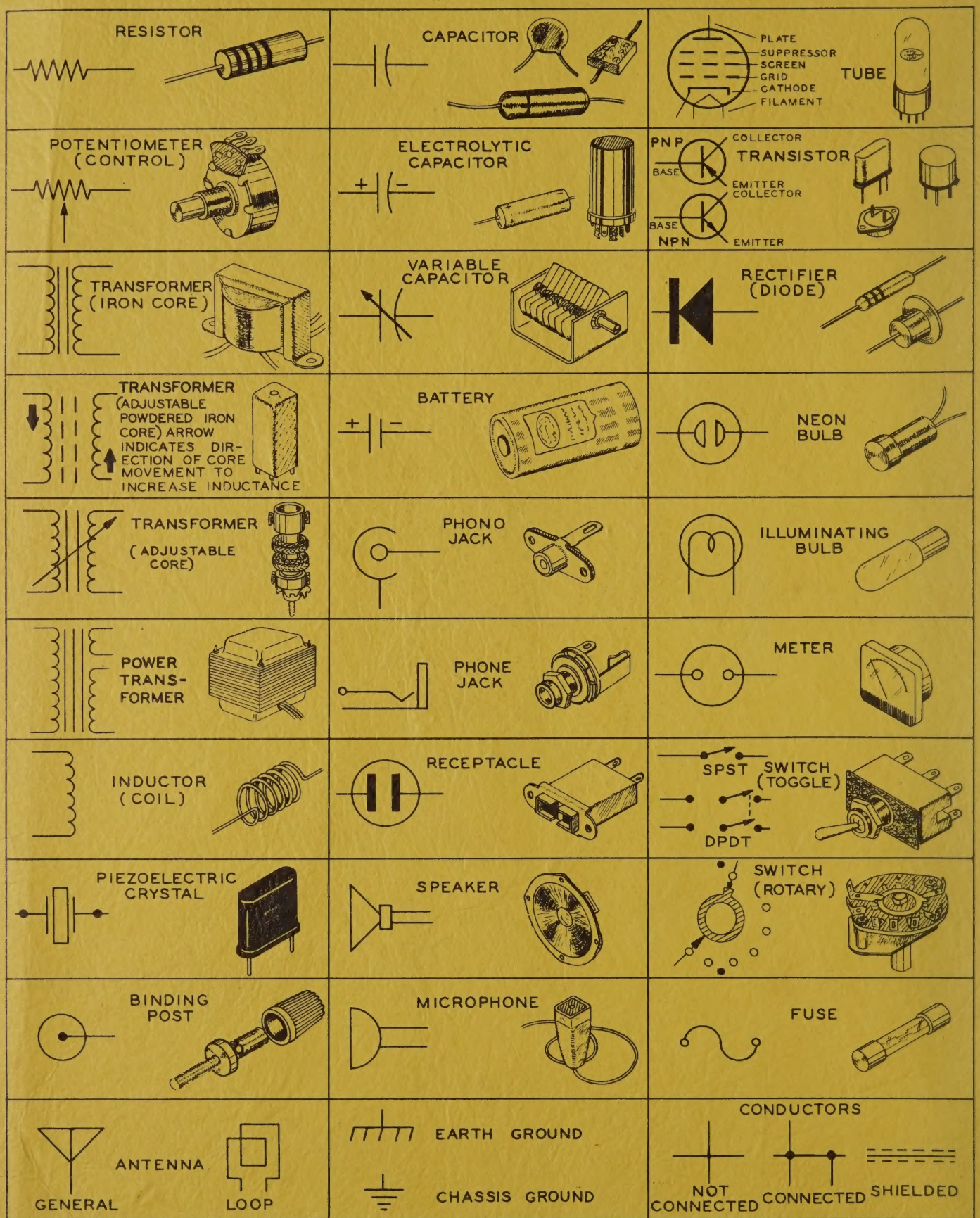
595-1285-01

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.



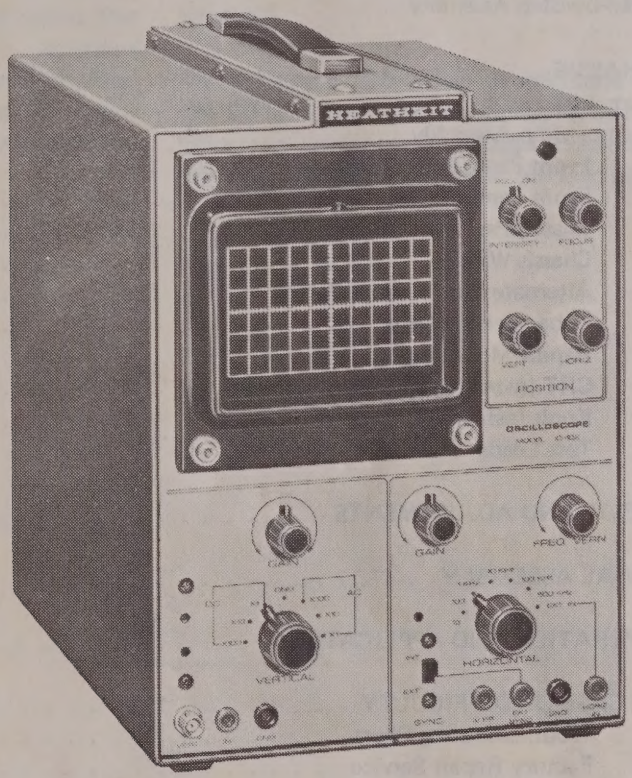
Assembly and Operation

of the

HEATHKIT

GENERAL PURPOSE SOLID-STATE 5" OSCILLOSCOPE

MODEL IO-102



HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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INTRODUCTION

The cathode ray oscilloscope is one of the most versatile instruments available. It can be used to measure ac and dc voltages, frequency, or phase, as well as study the waveforms of complex signals. These capabilities make the oscilloscope valuable for waveform analysis, particularly in audio, television, and transmitter work.

The Heathkit Model IO-102 General Purpose Solid-State 5" Oscilloscope is an economical and rugged instrument that includes some of the features of more expensive oscilloscopes. The dc to 5 megahertz vertical amplifier bandwidth and the excellent input sensitivity allow this Oscilloscope to be used for nearly all types of waveform display applications.

This Oscilloscope uses four printed circuit boards which minimize point-to-point wiring and reduce construction time. The transformer-operated, silicon rectifier power supplies can be wired to operate from 110-130 volt, or 220-260 volt ac power lines. This Oscilloscope has excellent display stability because both amplifiers and the sweep circuit power supplies are zener regulated. The primary circuit of the power transformer is fused for protection from overload.

Other features include: an all solid-state circuit (except for the CRT), a high input sensitivity, modern styling, moderate price, and versatility. Its rugged construction and ease of operation add to its usefulness and long life.

UNPACKING

The Oscilloscope packaging consists of the large shipping carton, which contains smaller packages and a number of loose parts. Some of the smaller packages have numbers 1 through 4 stamped on them. After these four numbered packages have been removed from the large carton, the remaining parts in the carton will be package #5.

You will be directed to open each package as it is needed. Each of the assembly sections of the Manual contains its own parts list and step-by-step instructions. At the beginning of each parts list, you will be instructed which numbered package to open. You will also be directed to remove some of the parts from package #5 to complete each assembly section.

To avoid intermixing parts, do not open any of the parts packages, until directed to do so at the beginning of one of the parts lists. Any part that is packaged in an individual envelope with a part number on it should be placed back in its envelope after it is identified, until that part is called for in a step.

Refer to the "Kit Builders Guide" for additional information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

To order replacement parts, refer to the "Replacement Parts Price List" and use the Parts Order Form furnished with this kit.

POWER SUPPLY CIRCUIT BOARD

PARTS LIST

Unpack the package marked 1 and check each part against the following list. The key numbers correspond to the numbers on the "Power Supply Circuit Board Parts Pictorial" (fold-out from Page 11). Any part that is packaged in an individual envelope with a part number on it should be placed back in its envelope after it is identified until it is called for in a step.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS			
1/2-Watt, 10%			
1	1-9	1	1000 Ω (brown-black-red)
1	1-35	1	1 MΩ (brown-black-green)
1-Watt, 10%			
2	1-19-1	7	220 Ω (red-red-brown)
2	1-32-1	1	470 kΩ (yellow-violet-yellow)
2	1-37-1	1	3.3 MΩ (orange-orange-green)
7-Watt, 10%			
3	3-14-7	1	2000 Ω (2 kΩ)
3	3-2-7	1	3750 Ω
3	3-21-7	1	4700 Ω (4.7 kΩ)
CAPACITORS			
4	23-62	3	.1 μF, 1600 V
5	25-43	1	70 μF, 350 V, electrolytic
5	25-121	1	500 μF, 50 V, electrolytic
DIODES			
6	56-48	2	110 V, 15 mA, zener
6	56-55	1	36 V, 4 mA, zener
6	56-66	1	43 V, 6 mA, zener
6	56-68	1	68 V, 7 mA, zener
6	57-27	8	1N2071, silicon
6	57-52	2	2 kV, 5 mA, silicon

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
TRANSISTOR			

NOTE: Transistors are marked for identification in one of the following four ways:

1. Part number.
2. Transistor type number.
3. Part number and transistor type number.
4. Part number with a transistor type number other than the one listed.

7	417-175	1	TA2911 transistor
MISCELLANEOUS			
	344-50	1	Black wire
	344-52	1	Red wire
	344-59	1	White wire
PARTS FROM PACK #5			
	85-470-3	1	Power supply circuit board
	597-308	1	Kit Builders Guide
		1	Manual (See front cover for part number.)
			Solder

STEP-BY-STEP ASSEMBLY

START

Position the power supply circuit board as shown in Pictorial 1-1. Then complete each step on the Pictorial.

( ) 1 MΩ (brown-black-green).

( ) 3.3 MΩ (orange-orange-green), 1-watt.

FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN...

WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) 220 Ω (red-red-brown), 1-watt.

( ) 220 Ω (red-red-brown), 1-watt.

( ) 220 Ω (red-red-brown), 1-watt.

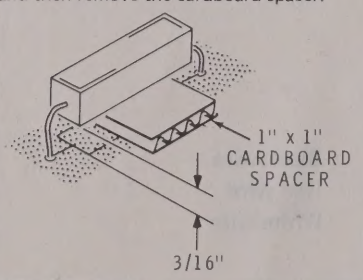
( ) 220 Ω (red-red-brown), 1-watt.

( ) 220 Ω (red-red-brown), 1-watt.

( ) 1000 Ω (brown-black-red).

( ) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: Mount the following three resistors 3/16" above the circuit board as shown. Use a 1" x 1" piece of 3/16" cardboard, (from shipping carton) for a spacer. Solder each resistor as it is installed, cut off the excess lead lengths, and then remove the cardboard spacer.

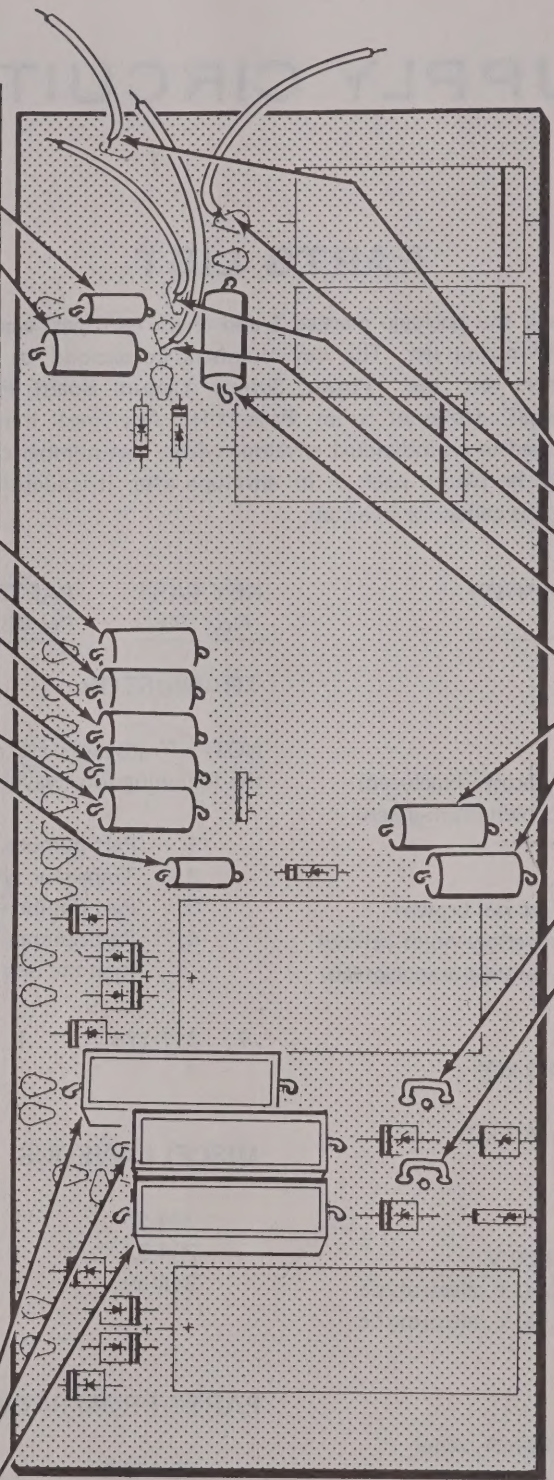


( ) 4700 Ω (4.7 kΩ), 7-watt.

( ) 2000 Ω (2 kΩ), 7-watt.

( ) 3750 Ω, 7-watt.

( ) Set the cardboard spacer aside for use later.



PICTORIAL 1-1

CONTINUE

NOTE: When a wire is called for, cut the wire to the specified length and remove 1/4" of insulation from each end. Solder each wire to the foil as it is installed. Any loose wire ends will be connected later.

( ) 2-1/2" white wire at A.

( ) 4-1/2" white wire at D.

( ) 5" black wire at C.

( ) 5-1/2" red wire at F.

( ) 470 kΩ (yellow-violet-yellow), 1-watt.

( ) 220 Ω (red-red-brown), 1-watt.

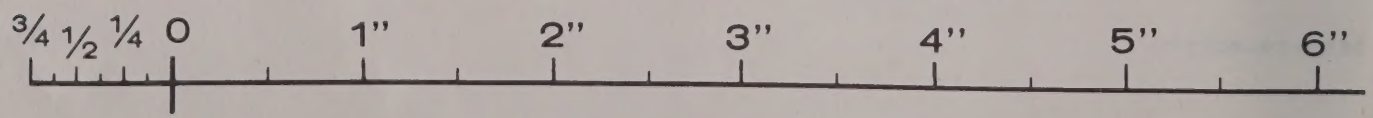
( ) 220 Ω (red-red-brown), 1-watt.

NOTE: Save the remaining lengths of wire. They will be used later.

( ) 1" bare wire (use a cut-off resistor lead).

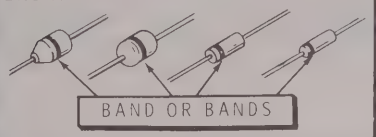
( ) 1" bare wire (use a cut-off resistor lead).

( ) Check to see that all connections are soldered and cut off any excess lead lengths.



START

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. THE CATHODE END OF THE DIODE IS MARKED WITH A BAND OR BANDS. ALWAYS POSITION THIS END AS SHOWN IN THE PICTORIAL.

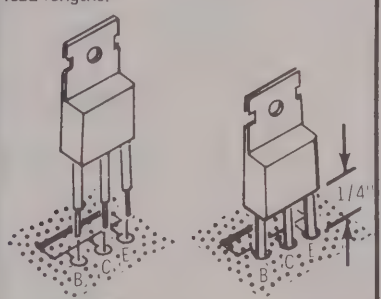


( ) Silicon diode (#57-52) at D301.

( ) Silicon diode (#57-52) at D302.

( ) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: In the next step, install the transistor in the following manner as shown: Insert the transistor leads into their corresponding holes in the circuit board, which are indicated by B, C, and E. Then solder each lead to the foil and cut off the excess lead lengths.



( ) TA2911 transistor (#417-175) at Q301.

( ) Silicon diode (#57-27) at D304.

( ) Silicon diode (#57-27) at D305.

( ) Silicon diode (#57-27) at D307.

( ) Silicon diode (#57-27) at D306.

( ) Solder the leads to the foil and cut off the excess lead lengths.

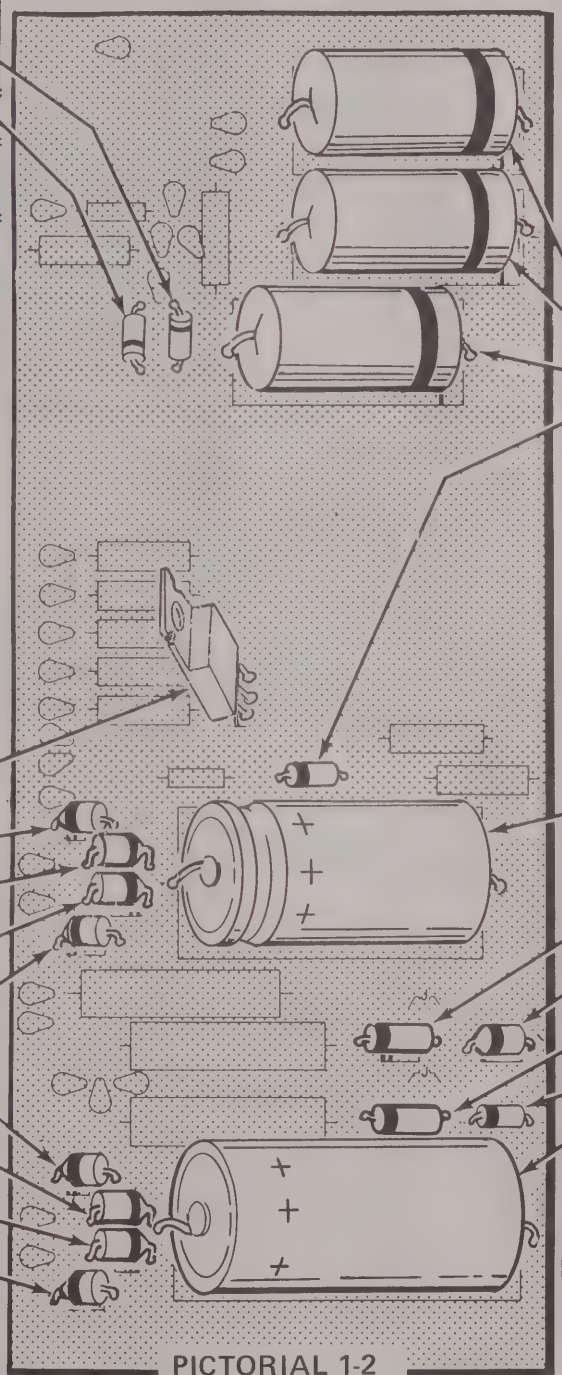
( ) Silicon diode (#57-27) at D312.

( ) Silicon diode (#57-27) at D313.

( ) Silicon diode (#57-27) at D315.

( ) Silicon diode (#57-27) at D314.

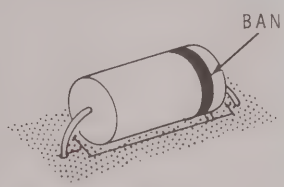
( ) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 1-2

CONTINUE

NOTE: When you install the following three capacitors, always match the banded end of each capacitor with the band mark on the circuit board.



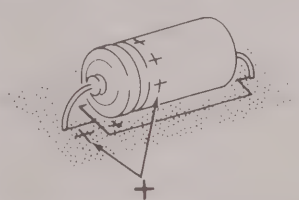
( ) .1 μF, 1600 V (1.6 kV) capacitor.

( ) .1 μF, 1600 V (1.6 kV) capacitor.

( ) .1 μF, 1600 V (1.6 kV) capacitor.

( ) Zener diode (#56-55) at ZD303.

NOTE: When you install an electrolytic capacitor, always match the positive (+) marked end of the capacitor with the positive (+) mark on the circuit board.



( ) 500 μF electrolytic.

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) Zener diode (#56-48) at ZD308.

( ) Zener diode (#56-68) at ZD309.

( ) Zener diode (#56-48) at ZD310.

( ) Zener diode (#56-66) at ZD311.

( ) 70 μF electrolytic.

( ) Solder the leads to the foil and cut off the excess lead lengths.

Set the power supply circuit board aside.

VERTICAL AMPLIFIER CIRCUIT BOARD

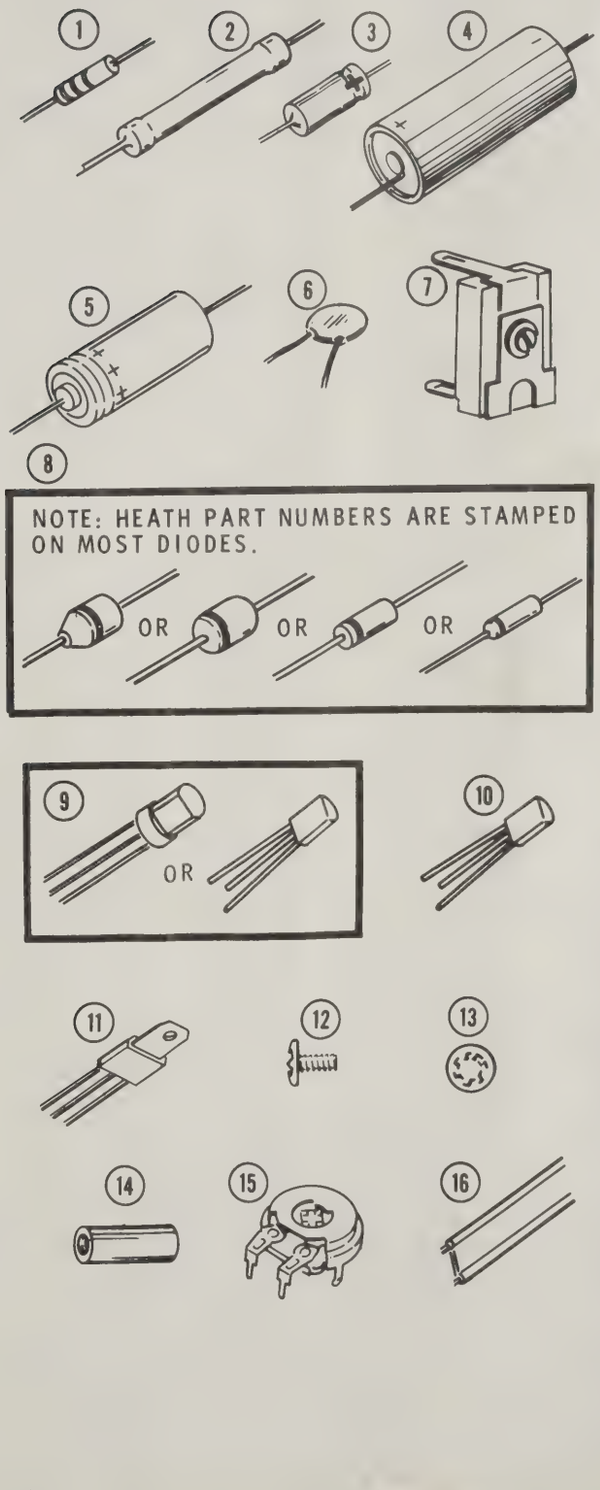
PARTS LIST

Unpack the package marked 2 and check each part against the following list. The key numbers correspond to the numbers on the "Vertical Amplifier Circuit Board Parts Pictorial" (fold-out from this page). Any part that is packaged in an individual envelope with a part number on it should be placed back in its envelope after it is identified until it is called for in a step.

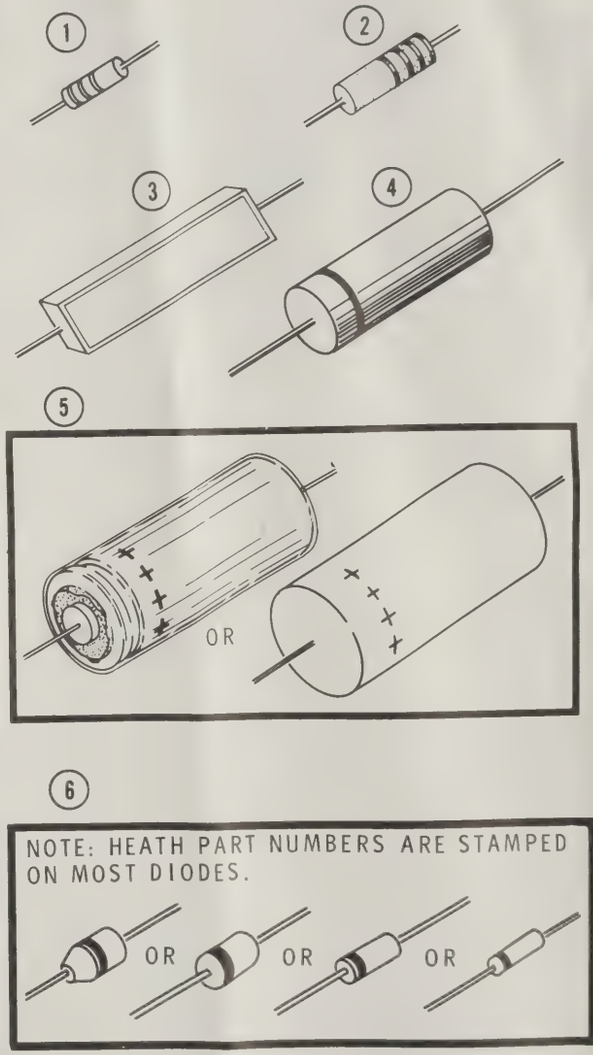
KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS			
1/2-Watt, 10%			
1	1-3	4	100 Ω (brown-black-brown)
1	1-4	2	330 Ω (orange-orange-brown)
1	1-9	5	1000 Ω (brown-black-red)
1	1-20	1	10 kΩ (brown-black-orange)
1	1-35	1	1 MΩ (brown-black-green)
4-Watt, 10%			
2	5-1-4	2	5600 Ω (5.6 k)
CAPACITORS			
Electrolytic			
3	25-54	1	10 μF, 15 V
4	25-20	1	40 μF, 150 V
5	25-111	1	1000 μF, 15 V
Disc			
6	21-11	1	150 pF
6	21-56	1	470 pF
6	21-16	1	.01 μF
Other Capacitor			
7	31-49	1	250-1000 pF trimmer
DIODES			
8	56-19	2	9.1 V, 25 mA, zener
8	56-56	2	1N4149 silicon
TRANSISTORS			
9	417-83	4	L842
9	417-118	2	2N3393
9	417-201	2	X29A829
10	417-169	2	MPF105
11	417-245	2	D40N1
HARDWARE			
12	250-229	4	6-32 x 1/4" screw
13	254-1	4	#6 lockwasher
14	255-94	4	1/2" threaded spacer
MISCELLANEOUS			
15	10-381	1	500 Ω control
15	10-397	1	200 Ω control
	343-7	1	Coaxial cable
16	347-2	1	Twin lead
PART FROM PACK #5			
	85-468-1	1	Vertical amplifier circuit board

PARTS PICTORIALS

VERTICAL AMPLIFIER CIRCUIT BOARD

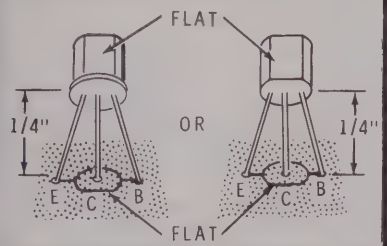


POWER SUPPLY CIRCUIT BOARD



START

NOTE: Install each of the next six transistors in the following manner as shown. Solder each lead to the foil and cut off the excess lead lengths.



( ) 2N3393 transistor (#417-118) at Q2.

( ) 2N3393 transistor (#417-118) at Q4.

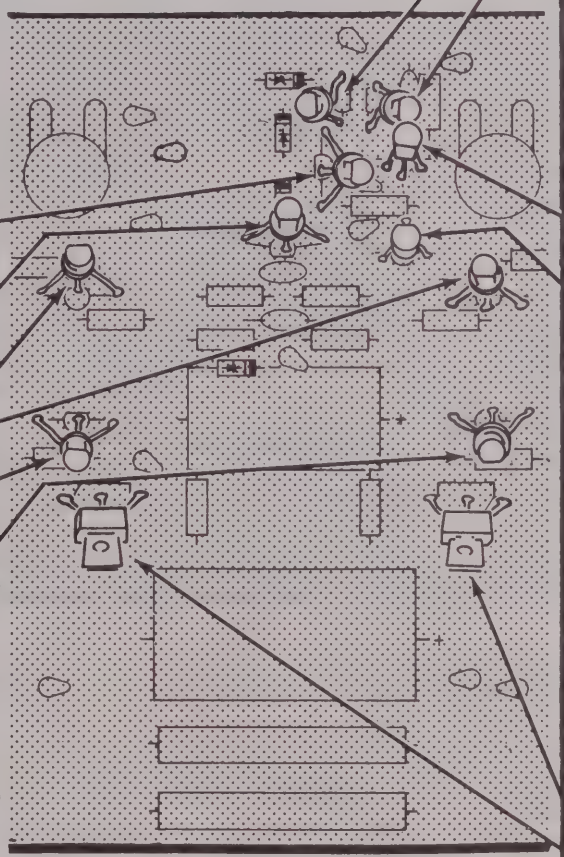
( ) L842 transistor (#417-83) at Q6.

( ) L842 transistor (#417-83) at Q5.

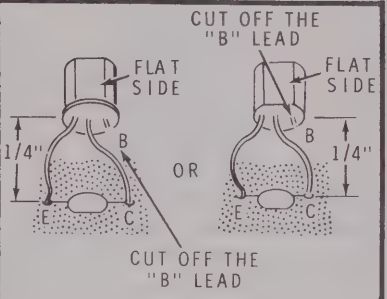
( ) X29A829 transistor (#417-201) at Q8.

( ) X29A829 transistor (#417-201) at Q7.

NOTE: Install the next two transistors in the following manner: Cut off the "B" lead and then insert the other two leads into their correct holes in the circuit board, which are indicated by E and C. Solder each lead to the foil and cut off the excess lead lengths.



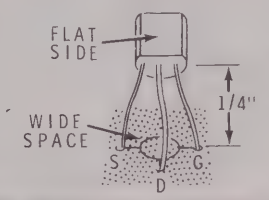
CONTINUE



( ) L842 transistor (#417-83) at D1.

( ) L842 transistor (#417-83) at D2.

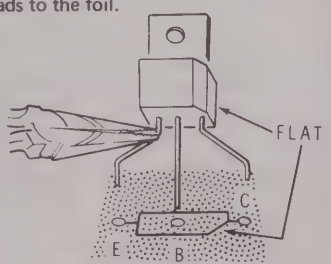
NOTE: Install the next two transistors as shown. Solder the leads to the foil.



( ) MPF105 transistor (#417-169) at Q1.

( ) MPF105 transistor (#417-169) at Q3.

NOTE: Install the next two transistors as shown. First, bend the transistor leads with a pair of long-nose pliers as shown. Then line up the flat of the transistor with the flat on the circuit board. Solder the leads to the foil.



( ) D40N1 transistor (#417-245) at Q9.

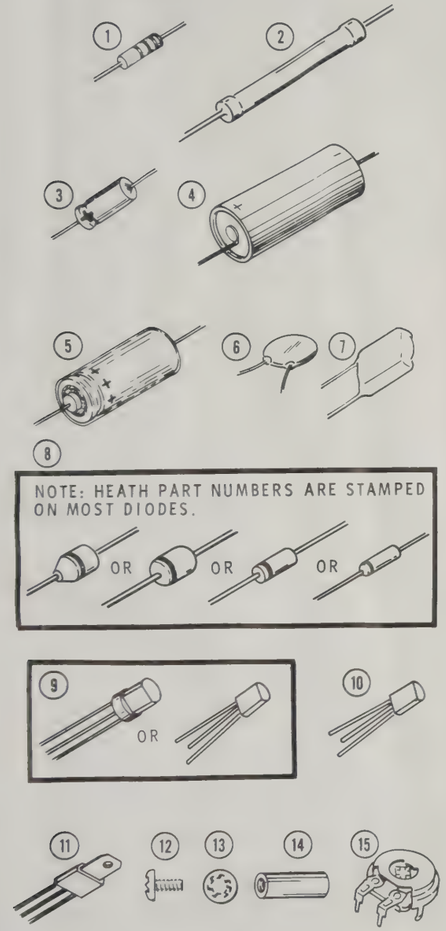
( ) D40N1 transistor (#417-245) at Q10.

( ) Check to see that all leads are soldered to the foil. Cut off any excess lead lengths.

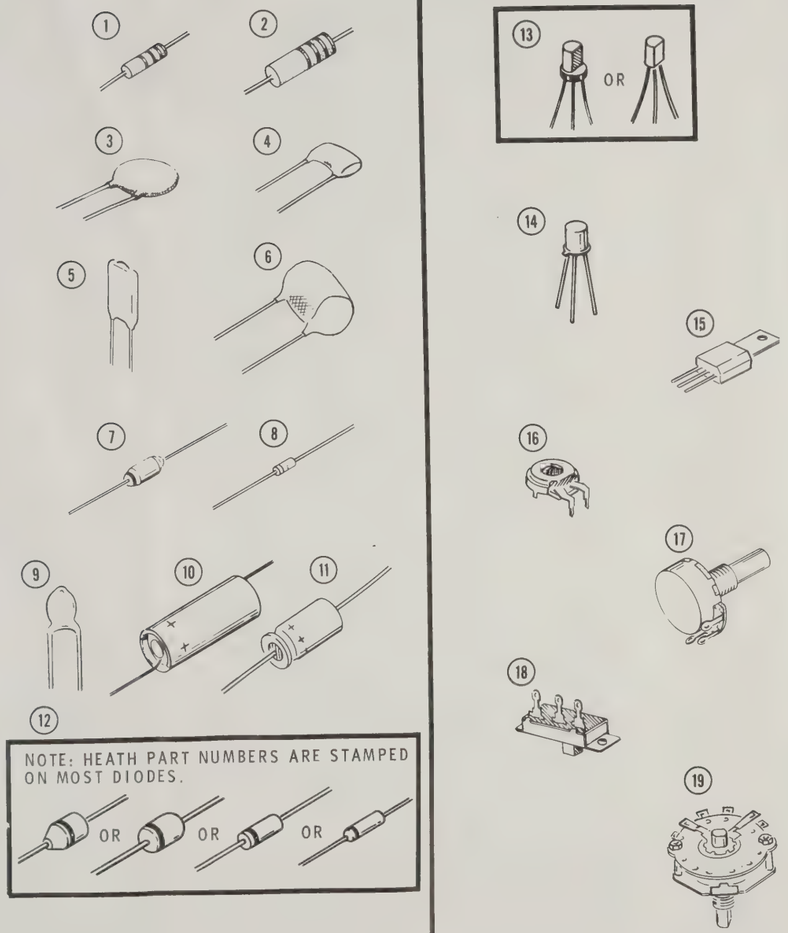
PICTORIAL 2-2

PARTS PICTORIALS

HORIZONTAL AMPLIFIER CIRCUIT BOARD



SWEEP CIRCUIT BOARD



STEP-BY-STEP ASSEMBLY

CONTINUE

START

Position the vertical amplifier circuit board as shown in Pictorial 2-1. Then complete each step on the Pictorial.

NOTE: Before installing disc capacitors in this kit use long-nose pliers to remove the excess insulation from the capacitor leads.

REMOVE INSULATION ON LEADS

( ) 470 pF disc.

( ) 100 Ω (brown-black-brown).

( ) 150 pF disc.

( ) 1000 Ω (brown-black-red).

( ) 100 Ω (brown-black-brown).

( ) 1000 Ω (brown-black-red).

( ) 330 Ω (orange-orange-brown).

FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN

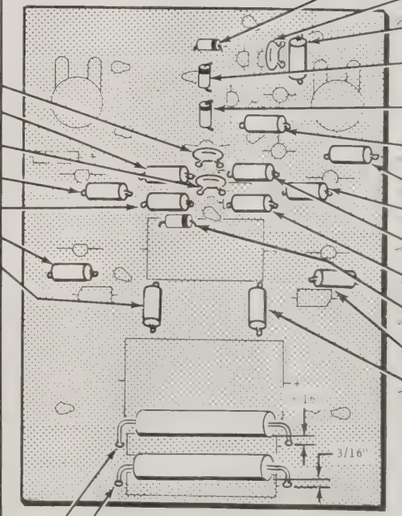
WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH

( ) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: Mount the following two resistors 3/16" above the circuit board. Use the cardboard spacer. Solder each resistor as it is installed, cut off the excess lead lengths, and then remove the cardboard spacer.

( ) 5600 Ω (5.6 k), 4-watt.

( ) 5600 Ω (5.6 k), 4-watt.



PICTORIAL 2-1

( ) Zener diode (#56-19) at ZD3.

( ) .01 μF disc.

( ) 1 MΩ (brown-black-green).

( ) 1N4149 silicon diode (#56-56) at D4.

( ) 1N4149 silicon diode (#56-56) at D5.

( ) 10 kΩ (brown-black-orange

( ) 1000 Ω (brown-black-red

( ) 1000 Ω (brown-black-red).

( ) 100 Ω (brown-black-brown)

( ) 100 Ω (brown-black-brown)

( ) Zener diode (#56-19) at ZD6.

( ) 1000 Ω (brown-black-red).

( ) 330 Ω (orange-orange-brown).

( ) Solder the leads to the foil and cut off the excess lead lengths.

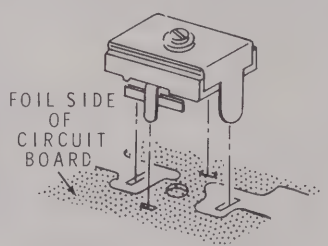
START

( ) 200 Ω control (#10-397).

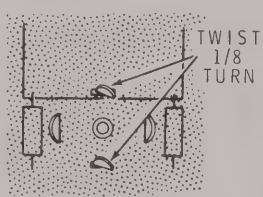
( ) 500 Ω control (#10-381).

( ) Solder the leads to the foil.

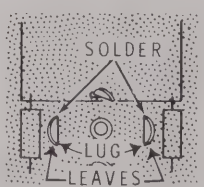
( ) Turn the circuit board foil side up and install the trimmer capacitor (#31-49) in the following manner, as shown.



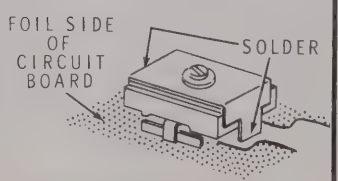
1. Twist the two indicated lugs (from the component side of the circuit board) 1/8 turn with pliers.

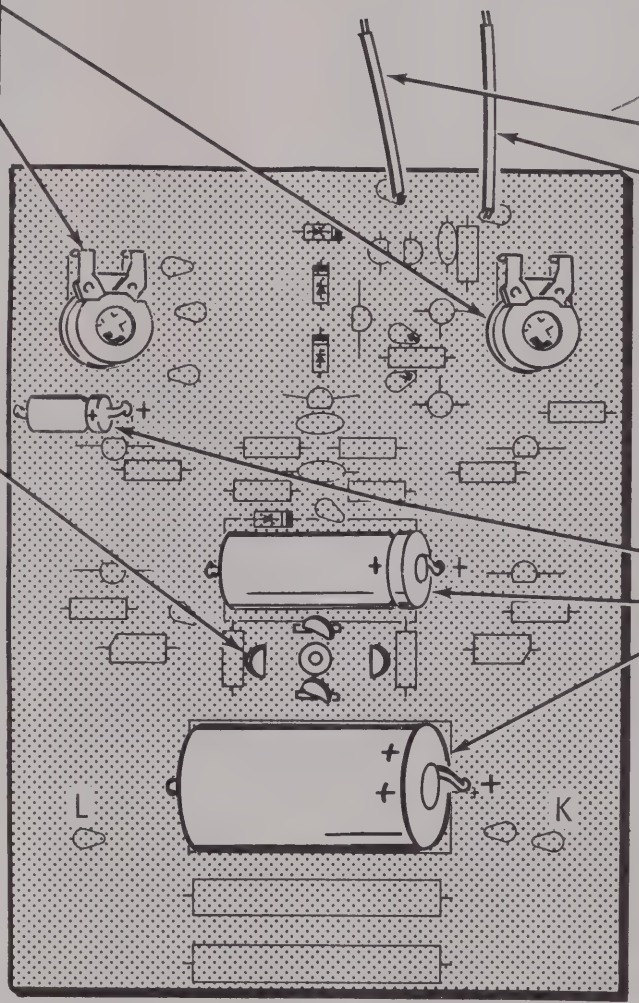


2. Solder all the small leaves to the two other indicated lugs (on the component side of the circuit board).



3. Solder the capacitor to the foil (on the foil side of the circuit board).





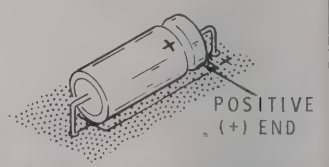
PICTORIAL 2-3

CONTINUE

( ) 3" white wire at B.

( ) 3" red wire at A.

NOTE: When you install an electrolytic capacitor, always match the positive-marked end of the capacitor with the positive (+) mark on the circuit board.

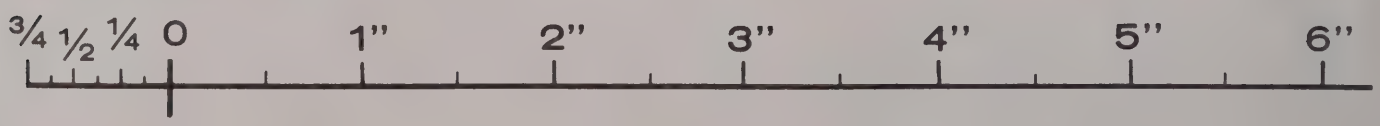


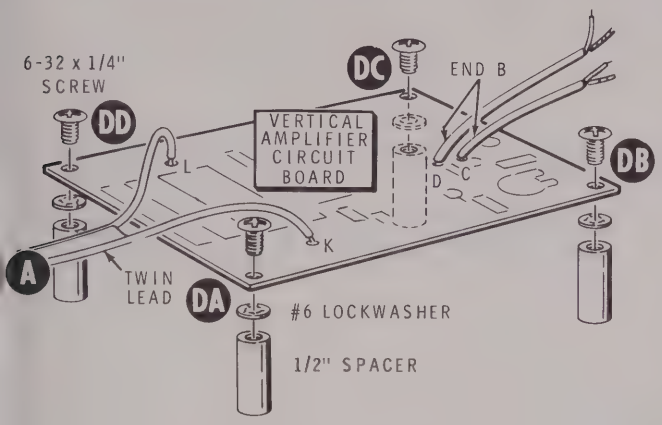
( ) 10 μF electrolytic.

( ) 1000 μF electrolytic.

( ) 40 μF electrolytic.

( ) Solder the leads to the foil and cut off the excess lead lengths.

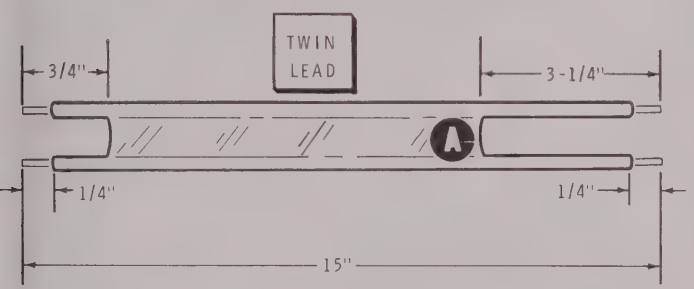




PICTORIAL 2-4

Refer to Pictorial 2-4 for the following steps.

( ) Refer to Detail 2-4A and prepare a length of twin lead to the dimensions shown. Then twist the bare wire strands together and melt a small amount of solder on the strands to hold them together. NOTE: The remaining length of twin lead will be used later.



Detail 2-4A

Refer to the Pictorial and connect end A of the twin lead to the vertical amplifier circuit board as follows:

( ) Connect either lead to hole L (S-1).

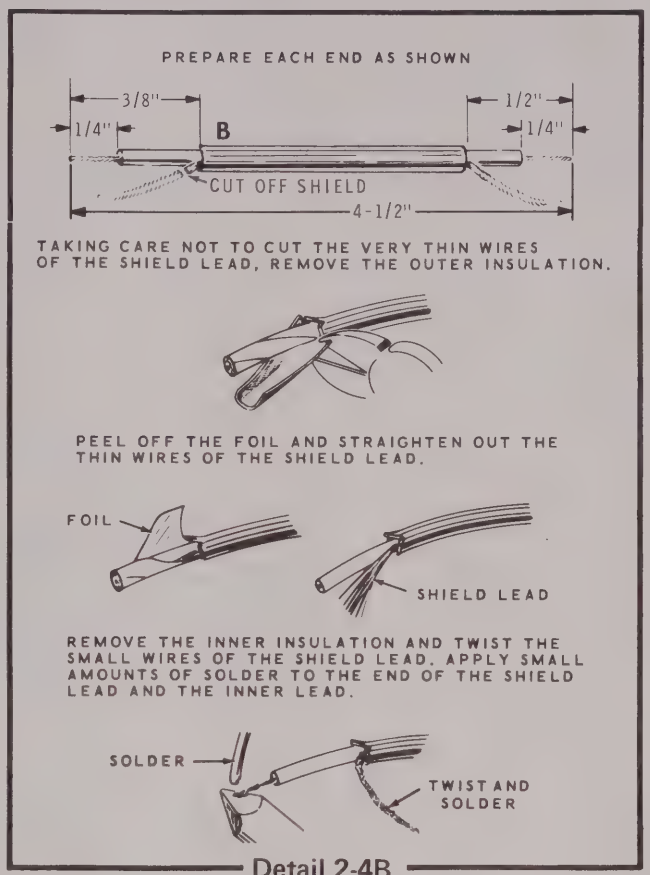
( ) Connect the other lead to hole K (S-1).

( ) Refer to Detail 2-4B and prepare a length of coaxial cable to the dimensions shown.

( ) Refer to the Pictorial and connect end B of the coaxial cable to hole D of the vertical amplifer circuit board.

( ) Refer to Detail 2-4C and prepare a length of coaxial cable to the dimensions shown.

( ) Refer to the Pictorial and connect end B of the coaxial cable to hole C of the vertical amplifier circuit board.

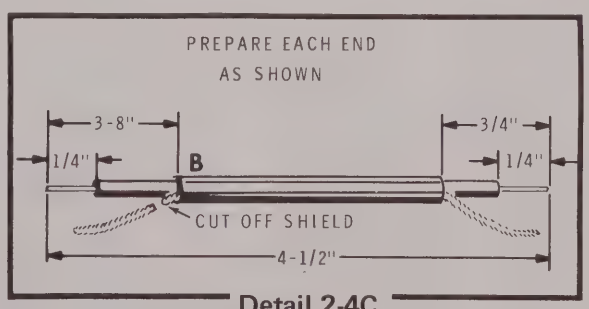


Detail 2-4B

NOTE: The term "hardware" will be used to refer to the screws, nuts, and lockwashers when parts are being mounted in this kit. The phrase "Use 6-32 x 1/4" hardware," for example, means to use a 6-32 x 1/4" screw, one or more #6 lockwashers, and perhaps a 6-32 nut. Refer to the Detail called out in the step for the correct number of lockwashers to use and the correct way to install the hardware.

( ) Install a 1/2" spacer at DA, DB, DC, and DD. Use 6-32 x 1/4" hardware.

( ) Set the vertical amplifier circuit board aside and proceed to Page 17.



Detail 2-4C

HORIZONTAL AMPLIFIER CIRCUIT BOARD

PARTS LIST

Unpack the package marked 3 and check each part against the following list. The key numbers correspond to the numbers on the "Horizontal Amplifier Circuit Board Parts Pictorial" (fold-out from Page 12). Any part that is packaged in an individual envelope with a part number on it should be placed back in its envelope after it is identified until it is called for in a step.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS			
1/2-Watt, 10%			
1	1-3	2	100 Ω (brown-black-brown)
1	1-6	2	470 Ω (yellow-violet-brown)
1	1-9	5	1000 Ω (brown-black-red)
1	1-20	1	10 kΩ (brown-black-orange)
1	1-35	1	1 MΩ (brown-black-green)
1	1-40	1	10 MΩ (brown-black-blue)
7-Watt, 5%			
2	5-3-7	2	10 kΩ
CAPACITORS			
Electrolytic			
3	25-54	1	10 μF, 15 V
4	25-71	1	30 μF, 200 V
5	25-111	1	1000 μF, 15 V
Disc			
6	21-56	2	470 pF
6	21-16	1	.01 μF
Mylar*			
7	27-77	1	.1 μF
DIODES			
8	56-19	2	9.1 V, 25 mA, zener
8	56-56	2	1N4149 silicon
TRANSISTORS			
9	417-118	6	2N3393
10	417-169	2	MPF105
11	417-245	2	D40N1
HARDWARE			
12	250-229	4	6-32 x 1/4" screw
13	254-1	4	#6 lockwasher
14	255-94	4	1/2" threaded spacer
MISCELLANEOUS			
15	10-381	2	500 Ω control
PART FROM PACK #5			
	85-468-2	1	Horizontal amplifier circuit board

*DuPont Registered Trademark

STEP-BY-STEP ASSEMBLY

START

Position the horizontal amplifier circuit board as shown in Pictorial 3-1. Then complete each step on the Pictorial.

( ) 1000 Ω (black-brown-red).

( ) 470 pF disc.

( ) 100 Ω (brown-black-brown).

( ) 1000 Ω (brown-black-red).

( ) 470 pF disc.

( ) 470 Ω (yellow-violet-brown).

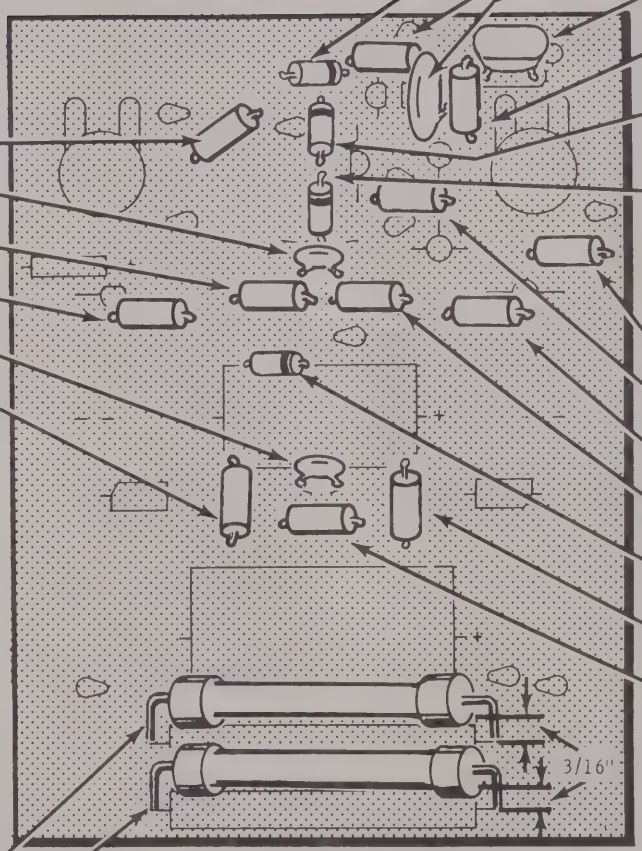
FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN... WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

( ) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: Mount the following two resistors 3/16" above the circuit board. Use the cardboard spacer. Solder each resistor as it is installed, cut off the excess lead lengths, and then remove the cardboard spacer.

( ) 10 kΩ, 7-watt.

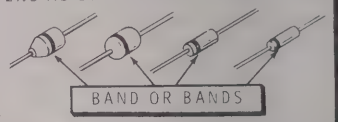
( ) 10 kΩ, 7-watt.



PICTORIAL 3-1

CONTINUE

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. THE CATHODE END OF THE DIODE IS MARKED WITH A BAND OR BANDS. ALWAYS POSITION THIS END AS SHOWN IN THE PICTORIAL.



( ) Zener diode (#56-19) at ZD203.

( ) 10 MΩ (brown-black-blue).

( ) .01 μF disc.

( ) .1 μF Mylar.

( ) 1 MΩ (brown-black-green).

( ) 1N4149 silicon diode (#56-56) at D204.

( ) 1N4149 silicon diode (#56-56) at D205.

( ) Solder the leads to the foil and cut off any excess lead lengths.

( ) 1000 Ω (brown-black-red).

( ) 10 kΩ (brown-black-orange).

( ) 1000 Ω (brown-black-red).

( ) 100 Ω (brown-black-brown).

( ) Zener diode (#56-19) at ZD206.

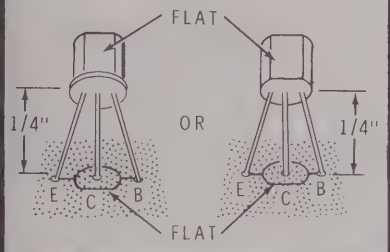
( ) 470 Ω (yellow-violet-brown).

( ) 1000 Ω (brown-black-red).

( ) Solder the leads to the foil and cut off the excess lead lengths.

START

NOTE: Install the next four transistors as shown. Solder each lead to the foil and cut off the excess lead lengths.



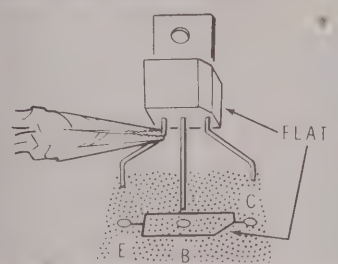
( ) 2N3393 transistor (#417-118) at Q202.

( ) 2N3393 transistor (#417-118) at Q204.

( ) 2N3393 transistor (#417-118) at Q206.

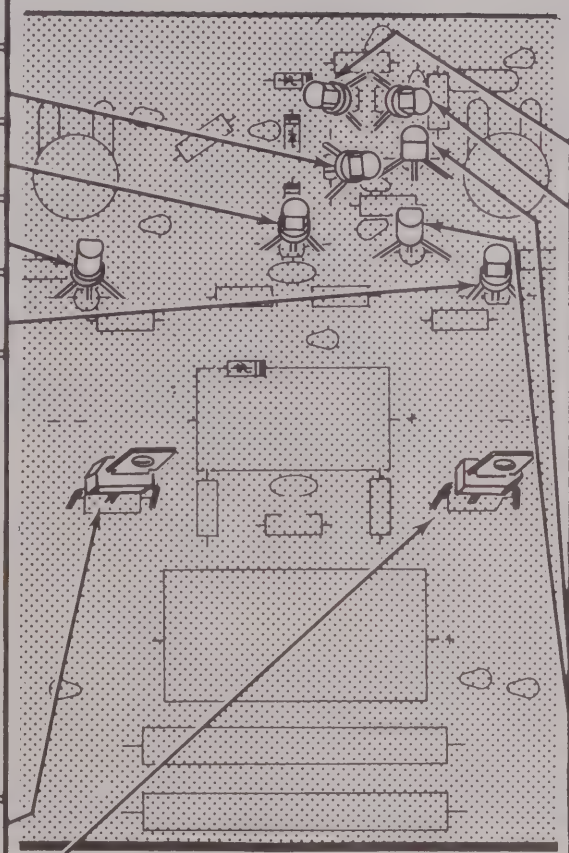
( ) 2N3393 transistor (#417-118) at Q205.

NOTE: Install the next two transistors in the following manner. First, bend the transistor leads with a pair of long-nose pliers as shown. Then line up the flat of the transistor with the flat on the circuit board. Solder the leads to the foil.



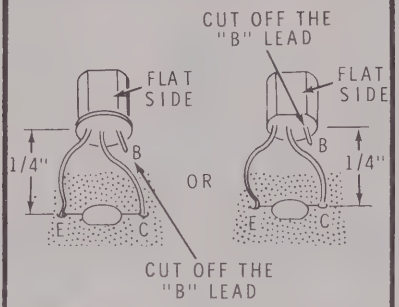
( ) D40N1 transistor (#417-245) at Q208.

( ) D40N1 transistor (#417-245) at Q207.



CONTINUE

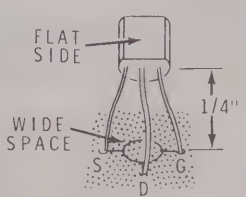
NOTE: Install the next two transistors as shown. Solder each lead to the foil and cut off the excess lead lengths.



( ) 2N3393 transistor (#417-118) at D201.

( ) 2N3393 transistor (#417-118) at D202.

NOTE: Install the next two transistors as shown. Solder the leads to the foil.

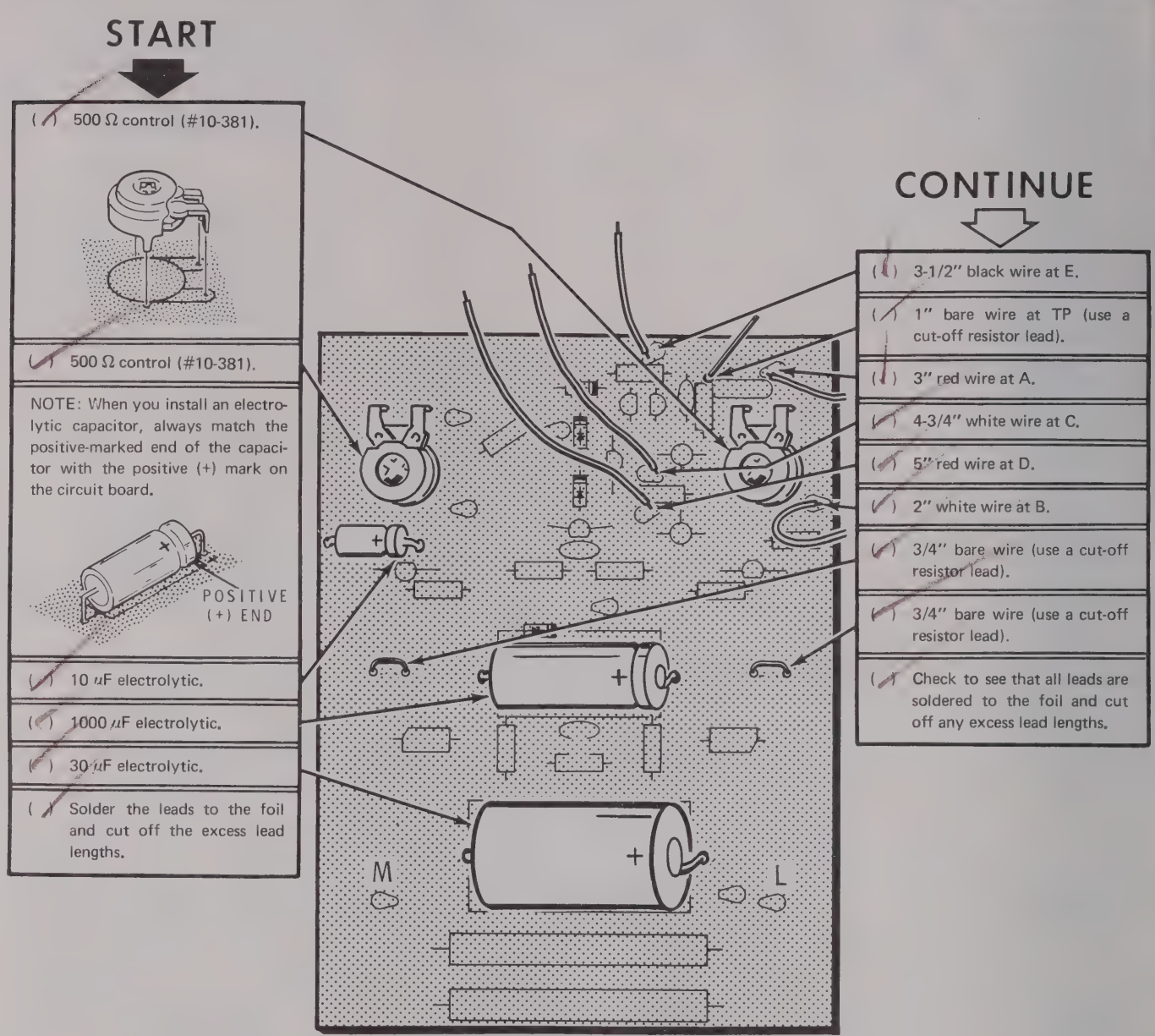


( ) MPF105 transistor (#417-169) at Q201.

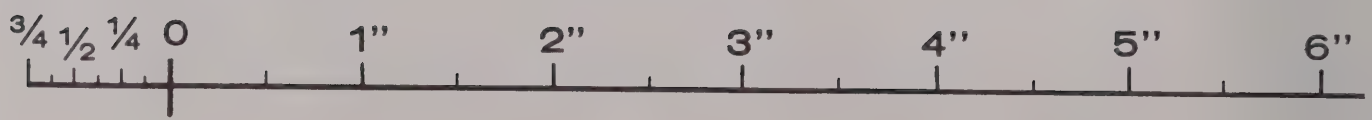
( ) MPF105 transistor (#417-169) at Q203.

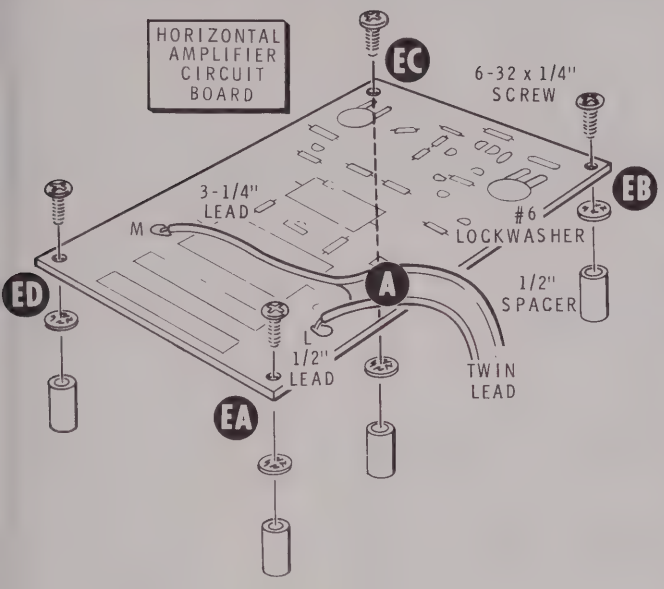
( ) Check to see that all leads are soldered to the foil and cut off any excess lead lengths.

PICTORIAL 3-2



PICTORIAL 3-3





PICTORIAL 3-4

Refer to Pictorial 3-4 for the following steps.

( ) Refer to Detail 3-4A and prepare a length of twin lead to the dimensions shown. Then twist the bare wire strands together and melt a small amount of solder on the strands to hold them together.

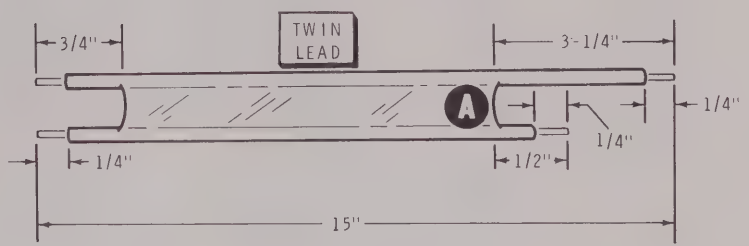
Refer to the Pictorial and connect end A of the twin lead to the horizontal amplifier circuit board as follows:

( ) Connect the 3-1/4" lead to hole M (S-1).

( ) Connect the 1/2" lead to hole L (S-1).

( ) Install 1/2" spacers at EA, EB, EC, and ED. Use 6-32 x 1/4" hardware.

Set the horizontal circuit board aside and proceed to Page 23.



Detail 3-4A

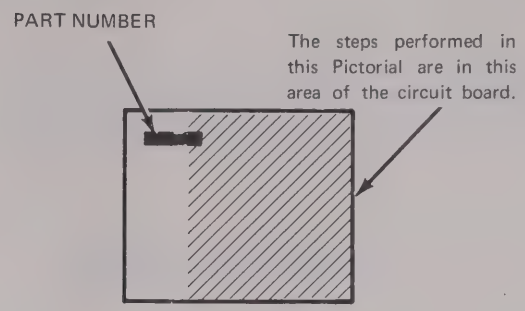
SWEEP CIRCUIT BOARD

PARTS LIST

Unpack the package marked 4 and check each part against the following list. The key numbers correspond to the numbers on the "Sweep Circuit Board Parts Pictorial" (fold-out from Page 12). Any part that is packaged in an individual envelope with a part number on it should be placed back in its envelope after it is identified until it is called for in a step.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS			
1/2-Watt, 10%			
1	1-3	3	100 Ω (brown-black-brown)
1	1-42	1	270 Ω (red-violet-brown)
1	1-6	3	470 Ω (yellow-violet-brown)
1	1-9	9	1000 Ω (brown-black-red)
1	1-16	3	4700 Ω (yellow-violet-red)
1	1-26	4	100 kΩ (brown-black-yellow)
1	1-35	2	1 MΩ (brown-black-green
1-Watt, 10%			
2	1-24-1	1	4700 Ω (yellow-violet-red)
CAPACITORS			
Disc			
3	21-56	2	470 pF
3	21-141	1	.0033 μF
3	21-16	2	.01 μF
3	21-42	1	.01 μF, 1.6 kV
Mica			
4	20-100	1	30 pF
Mylar			
5	27-74	1	.01 μF
5	27-77	3	.1 μF, 100 V
6	27-112	1	.1 μF, 600 V
Polystyrene			
7	29-5	1	1000 pF
Electrolytic			
8	25-197	1	1 μF tantalum
9	25-220	2	10 μF tantalum
10	25-20	1	40 μF, 150 V
11	25-111	1	1000 μF, 15 V
DIODES			
12	56-19	1	9.1 V, 25 mA, zener
12	56-48	1	110 V, 15 mA, zener
TRANSISTORS			
13	417-83	1	L842
13	417-118	3	2N3393
13	417-201	2	X29A829
13	417-221	3	TZ582
13	417-169	1	MPF105
14	417-154	2	2N2369A
15	417-245	1	D40N1
MISCELLANEOUS			
16	10-381	1	500 Ω control
17	10-258	1	10 kΩ control
18	60-4	1	Slide switch
	74-4	1	Tape
PARTS FROM PACK #5			
19	63-589	1	Rotary switch
19	85-469-1	1	Sweep circuit board

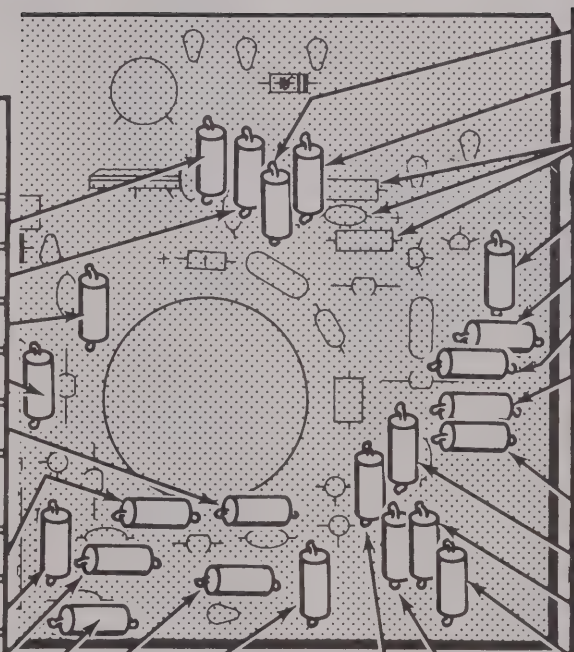
STEP-BY-STEP ASSEMBLY



START

Position the sweep circuit board as shown in the identification drawing. Then complete each step on the Pictorial.

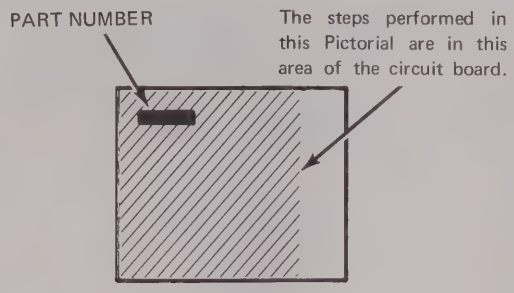
- ( ) 100 Ω (brown-black-brown).
- ( ) 100 kΩ (brown-black-yellow).
- ( ) 1000 Ω (brown-black-red).
- ( ) 4700 Ω (yellow-violet-red).
- ( ) 100 Ω (brown-black-brown).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.
- ( ) 1000 Ω (brown-black-red).
- ( ) 100 kΩ (brown-black-yellow).
- ( ) 270 Ω (red-violet-brown).
- ( ) 1 MΩ (brown-black-green).
- ( ) 1000 Ω (brown-black-red).
- ( ) 4700 Ω (yellow-violet-red).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

- ( ) 470 Ω (yellow-violet-brown).
- ( ) 1000 Ω (brown-black-red).
- NOTE: These components will be installed later.
- ( ) 100 kΩ (brown-black-yellow).
- ( ) 1000 Ω (brown-black-red).
- ( ) 100 kΩ (brown-black-yellow).
- ( ) 100 Ω (brown-black-brown).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.
- ( ) 1000 Ω (brown-black-red).
- ( ) 1000 Ω (brown-black-red).
- ( ) 1000 Ω (brown-black-red).
- ( ) 1 MΩ (brown-black-green).
- ( ) 4700 Ω (yellow-violet-red).
- ( ) 1000 Ω (brown-black-red).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

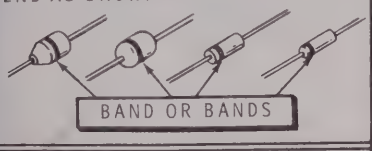
PICTORIAL 4-1



IDENTIFICATION DRAWING

START

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. THE CATHODE END OF THE DIODE IS MARKED WITH A BAND OR BANDS. ALWAYS POSITION THIS END AS SHOWN IN THE PICTORIAL.



( ) Zener diode (#56-19) at ZD104.

( ) .01 µF, 1.6 kV disc. Lay this capacitor down against the circuit board.

( ) .0033 µF disc.

( ) 4700 Ω (yellow-violet-red), 1-watt.

( ) Zener diode (#56-48) at ZD101.

( ) .01 µF disc.

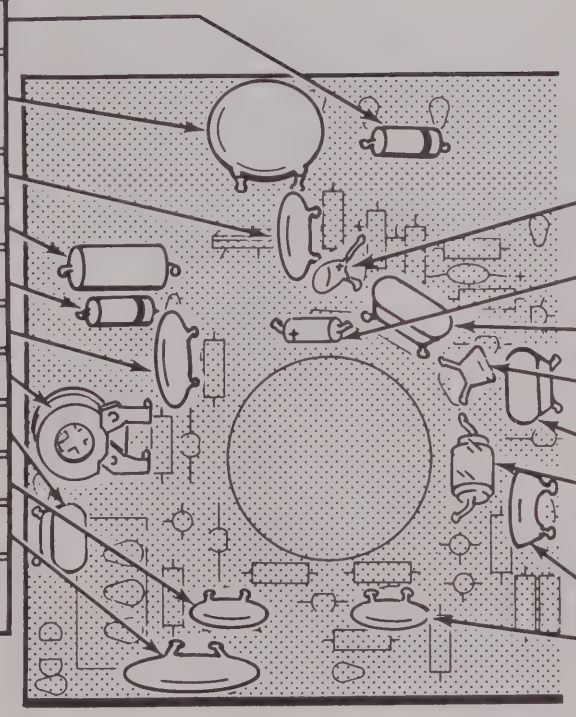
( ) 500 Ω control (#10-381).

( ) .1 µF, 100 V, Mylar.

( ) 470 pF disc.

( ) .01 µF disc.

( ) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

NOTE: When installing any electrolytic capacitor, always match the positive marked end (+ or red end) of the capacitor with the positive (+) mark on the circuit board.

( ) 10 µF electrolytic.

( ) 1 µF electrolytic. Position the + or red end as shown.

( ) .1 µF, 100 V, Mylar.

( ) .01 µF Mylar.

( ) .1 µF, 100 V, Mylar.

( ) .001 µF (1000 pF) polysytrene. NOTE: Disregard the red end on this capacitor.

( ) 30 pF Mica.

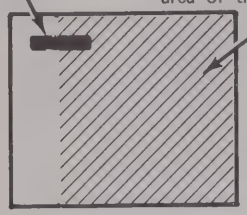
( ) 470 pF disc.

( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 4-2

PART NUMBER

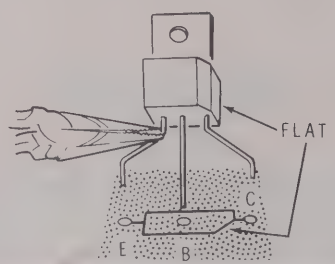
The steps performed in this Pictorial are in this area of the circuit board.



IDENTIFICATION DRAWING

START

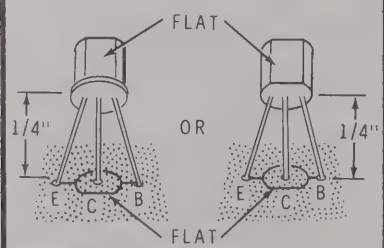
NOTE: Install the next transistor in the following manner. First, bend the transistor leads with a pair of long-nose pliers as shown. Then line up the flat of the transistor with the flat on the circuit board.



( ) D40N1 transistor (#417-245) at Q108. Bend the transistor down onto the .01 μF capacitor before soldering the transistor leads to the foil.

( ) Wrap a length of tape around the heat sink of the transistor as shown. Be sure that all of the heat sink is covered.

NOTE: Install the next five transistors as shown. Solder the leads to the foil.



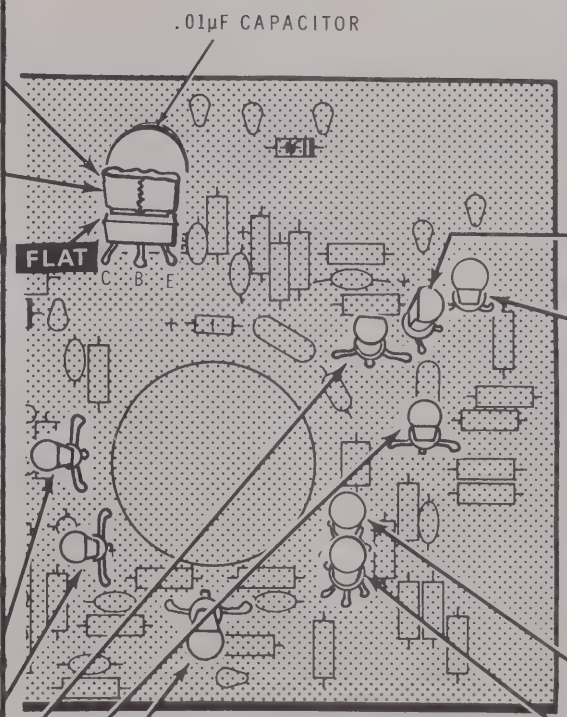
( ) 2N3393 transistor (#417-118) at Q102.

( ) L842 transistor (#417-83) at Q103.

( ) X29A829 transistor (#417-201) at Q111.

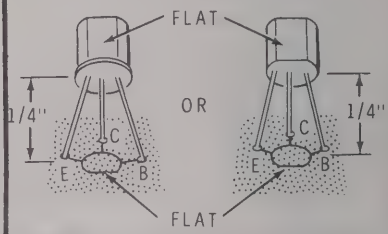
( ) TZ582 transistor (#417-221) at Q110.

( ) X29A829 transistor (#417-201) at Q104.



CONTINUE

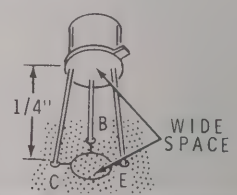
NOTE: Install the next two transistors as shown. Solder the leads to the foil.



( ) TZ582 transistor (#417-221) at Q109.

( ) TZ582 transistor (#417-221) at Q107.

NOTE: Install the next two transistors as shown. Solder the leads to the foil.

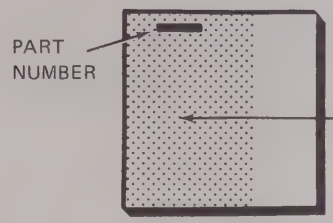


( ) 2N2369 transistor (#417-154) at Q106.

( ) 2N2369 transistor (#417-154) at Q105.

( ) Check to see that all leads are soldered to the foil and cut off any excess lead lengths.

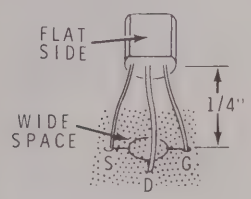
PICTORIAL 4-3



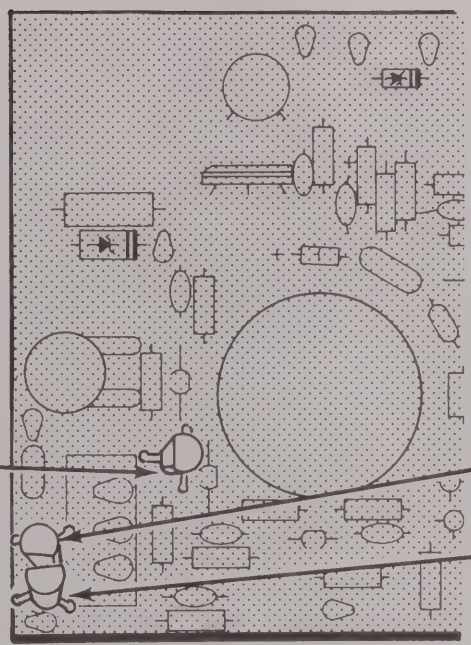
IDENTIFICATION
DRAWING

START

NOTE: Install the next transistor in the following manner as shown.

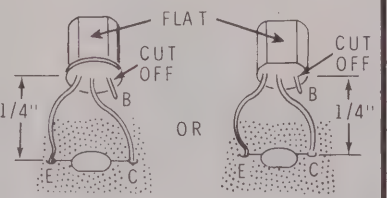


( ) MPF105 transistor (#417-169) at Q101.



CONTINUE

NOTE: Install the following two transistors as shown. Solder each lead to the foil and cut off the excess lead lengths.

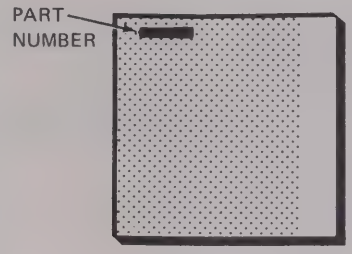


( ) 2N3393 transistor (#417-118) at D103.

( ) 2N3393 transistor (#417-118) at D102.

( ) Check to see that all leads are soldered to the foil and cut off any excess lead lengths.

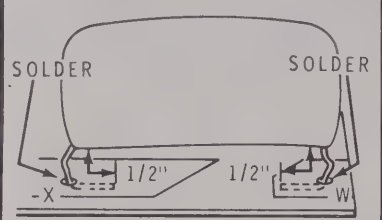
PICTORIAL 4-4



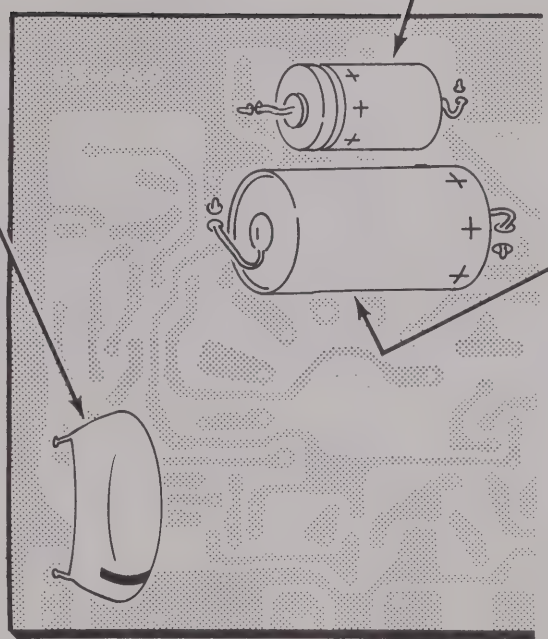
START

( ) Turn the circuit board over and position it (foil side up) as shown.

( ) .1 μF, 600 V, Mylar. Install this capacitor in the following manner, as shown: First cut both leads to a length of 1/2". Then insert the leads into holes W and X and bend the leads as shown. Solder each lead to the foil.



BEND LEADS
ON COMPONENT SIDE
OF CIRCUIT BOARD

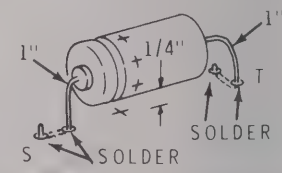


PICTORIAL 4-5

CONTINUE

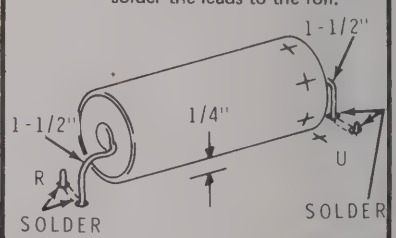
( ) 1000 μF electrolytic. Install this capacitor as follows:

1. Cut both leads to a length of 1".
2. Match the positive (+) marked end of the capacitor with the positive (+) mark on the circuit board.
3. Route the leads through the pairs of holes at T and S, forming the lead ends as shown.
4. Position the capacitor 1/4" above the circuit board. Be sure the leads are snug against the component side of the circuit board, as shown, and solder the leads to the foil.

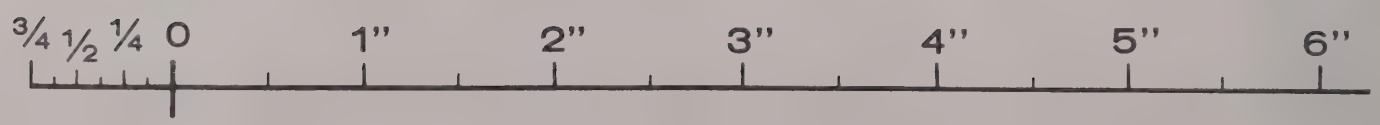


( ) 40 μF electrolytic. Install this capacitor as follows:

1. Cut both leads to a length of 1-1/2".
2. Match the positive (+) marked end of the capacitor with the positive (+) mark on the circuit board.
3. Route the leads through the pairs of holes at R and U, forming the lead ends as shown.
4. Position the capacitor 1/4" above the circuit board. Be sure the leads are snug against the component side of the circuit board, as shown, and solder the leads to the foil.



( ) Check to see that all leads are soldered to the foil and cut off any excess lead lengths.



START

( ) Turn the circuit board over and position it as shown.

NOTE: As you install each of the following wires and parts, solder the leads to the foil. Then cut off any excess lead lengths.

( ) 3-3/4" white wire at B.

( ) 470 Ω (yellow-violet-brown).

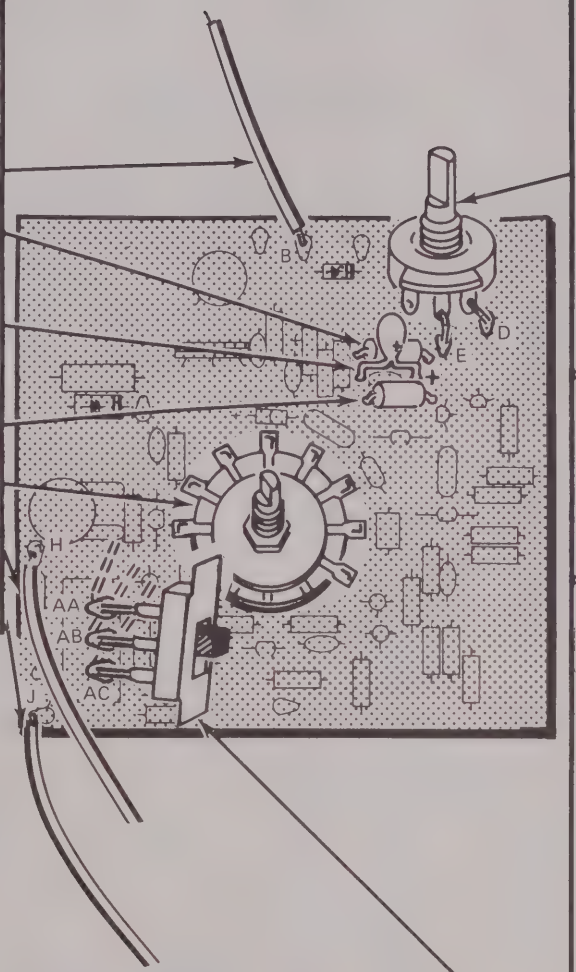
( ) 10 μF electrolytic. Match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board.

( ) 470 Ω (yellow-violet-brown).

( ) Rotary switch. Be sure it sits flat on the circuit board.

( ) 10" white wire at H.

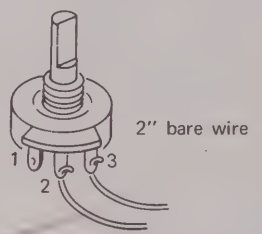
( ) 2-1/2" white wire at J.



CONTINUE

( ) Prepare the 10 kΩ control (#10-258) as follows:

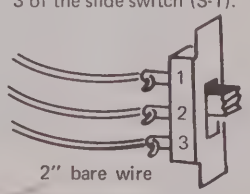
1. Cut two 2" lengths of white wire and remove the insulation from the wires.
2. Connect a 2" bare wire to lug 2 of the control (S-1).
3. Connect a 2" bare wire to lug 3 of the control (S-1).



( ) Install the 10 kΩ control by inserting the loose ends of the bare wires through holes D and E as shown. Then bend 1" of the bare wires over on the foil side of the circuit board, but do not solder the connections at this time.

( ) Prepare the slide switch as follows:

1. Cut three 2" lengths of white wire and remove the insulation from the wires.
2. Connect a 2" bare wire to lug 1 of the slide switch (S-1).
3. Connect a 2" bare wire to lug 2 of the slide switch (S-1).
4. Connect a 2" bare wire to lug 3 of the slide switch (S-1).



( ) Install the slide switch by inserting the loose ends of the bare wires through holes AA, AB, and AC as shown. Bend 1" of each bare wire over on the foil side of the circuit board, but do not solder the connections at this time.

Set the sweep circuit board aside.

PICTORIAL 4-6

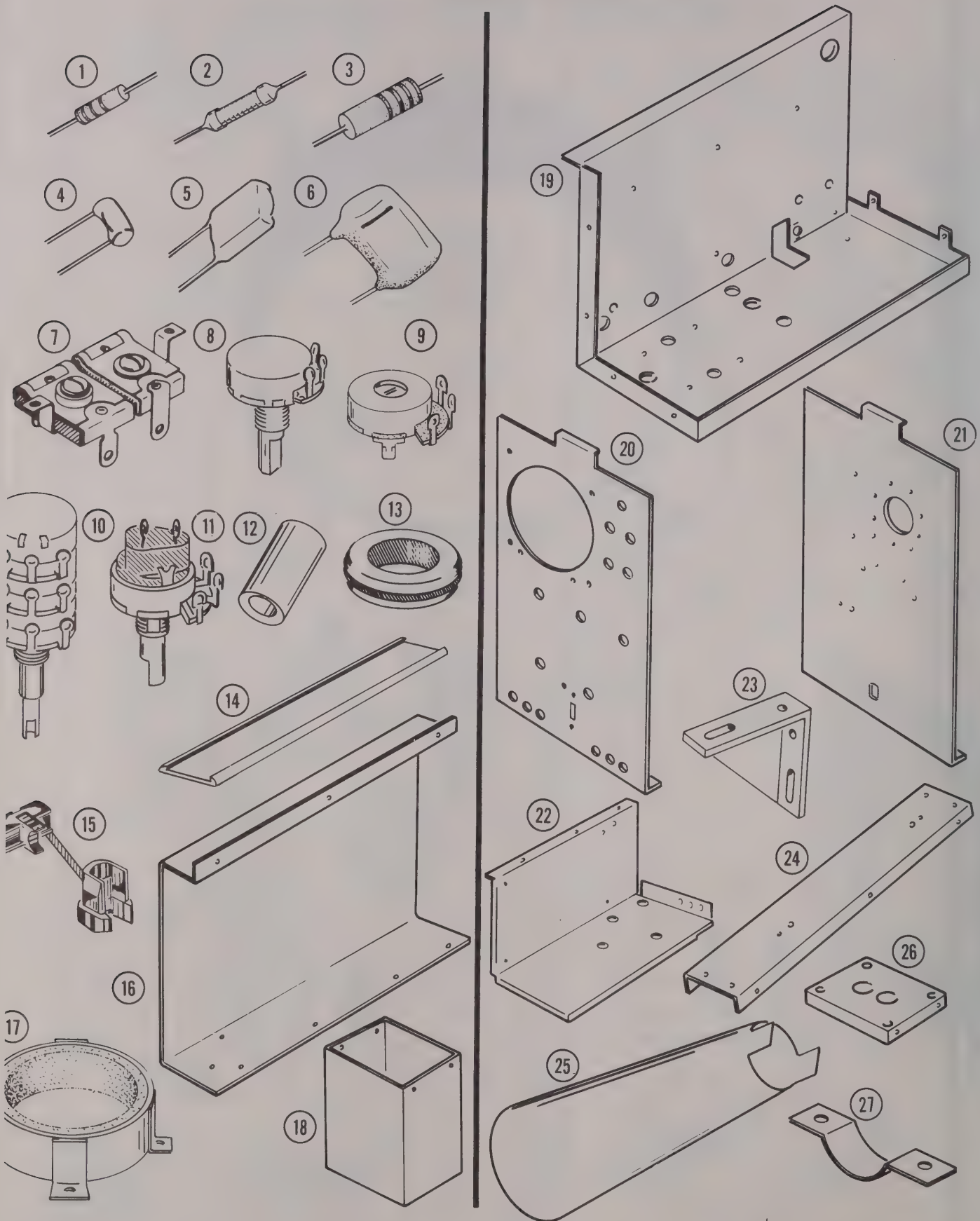
CHASSIS

PARTS LIST

Unpack package 5, which is all of the remaining parts, and check each part against the following list. The key numbers correspond to the numbers on the "Chassis Parts Pictorial" (fold-out from Page 31). Any part that is packaged in an individual envelope with a part number on it should be placed back in its envelope after it is identified until it is called for in a step.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS			
1/2-Watt, 10%			
1	1-26	1	100 kΩ (brown-black-yellow)
1	1-35	1	1 MΩ (brown-black-green)
1/2-Watt, 1%			
2	2-50	1	10 kΩ
2	2-41	1	90 kΩ
2	2-51	1	900 kΩ
1-Watt, 10%			
3	1-32-1	1	470 kΩ (yellow-violet-yellow)
CAPACITORS			
Mica			
4	20-100	1	30 pF
4	20-113	1	470 pF
Mylar			
5	27-77	1	.1 μF, 100 V
6	27-112	1	.1 μF, 600 V
Other Capacitor			
7	31-18	1	Dual trimmer
CONTROLS			
8	10-271	3	1000 Ω
8	10-224	1	1 MΩ
9	10-282	1	150 kΩ
10	13-9	1	Triple control
11	19-149	1	250 kΩ
INSULATORS			
12	70-5	1	Black insulator
12	70-6	1	Red insulator
13	73-2	6	Large rubber grommet
13	73-3	5	Small rubber grommet
14	73-5	1	Cushion strip
15	75-71	1	Line cord strain relief
METAL PARTS			
16	90-513-1	2	Cabinet shell
17	100-296	1	CRT ring
18	100-1046	1	Transformer side shield
19	200-598	1	Chassis
20	203-770-1	1	Front panel
21	203-771-1	1	Rear panel
22	204-1169	1	Circuit board mounting plate
23	204-1170	2	CRT mounting bracket
24	204-1171-1	1	Top bracket
25	206-304	1	Tube shield
26	206-518	1	Transformer top shield
27	207-1	2	CRT clamp

CHASSIS PARTS PICTORIAL

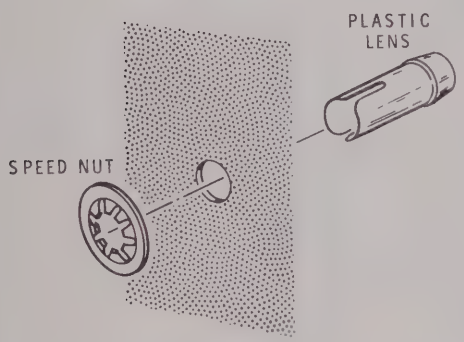


STEP-BY-STEP ASSEMBLY

FRONT PANEL PARTS MOUNTING

Refer to Pictorial 5-1 (fold-out from Page 32) for the following steps.

( ) Refer to Detail 5-1A and mount a plastic lens at AA as shown. Secure it in place by pushing the Speed Nut onto the plastic lens.



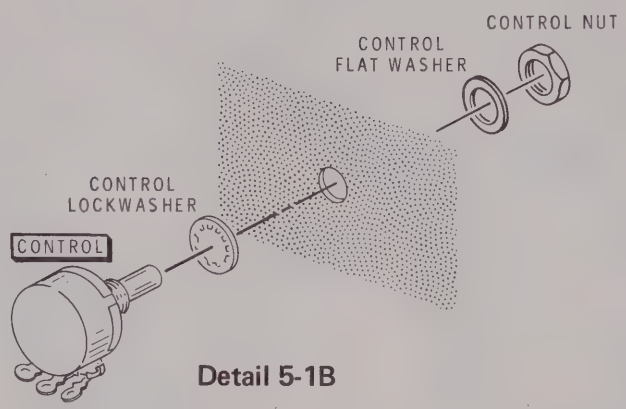
Detail 5-1A

Refer to Detail 5-1B for the following steps.

( ) Mount a 1 MΩ control (#10-224) at AB as shown. Use a control lockwasher, a control flat washer, and a control nut.

( ) Mount a 1000 Ω (1 k) control (#10-271) at AC as shown. Use a control lockwasher, a control flat washer, and a control nut.

( ) Mount a 1000 Ω (1 kΩ control (#10-271) at AD as shown. Use a control lockwasher, a control flat washer, and a control nut.



Detail 5-1B

Refer to Detail 5-1C for the following steps.

NOTE: When mounting the banana jacks in the following steps, use the nut supplied with the banana jack. After each jack is installed, bend the lug 90 degrees as shown in Pictorial 5-1.

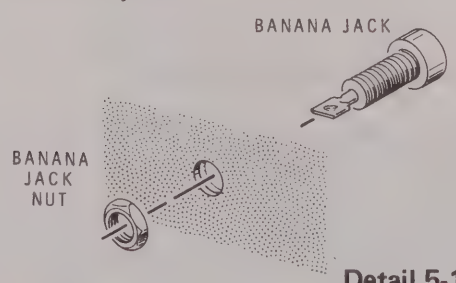
Mount the banana jacks as follows:

( ) Red banana jack at AE.

( ) Black banana jack at AF.

( ) Red banana jack at AG.

( ) Red banana jack at AH.



Detail 5-1C

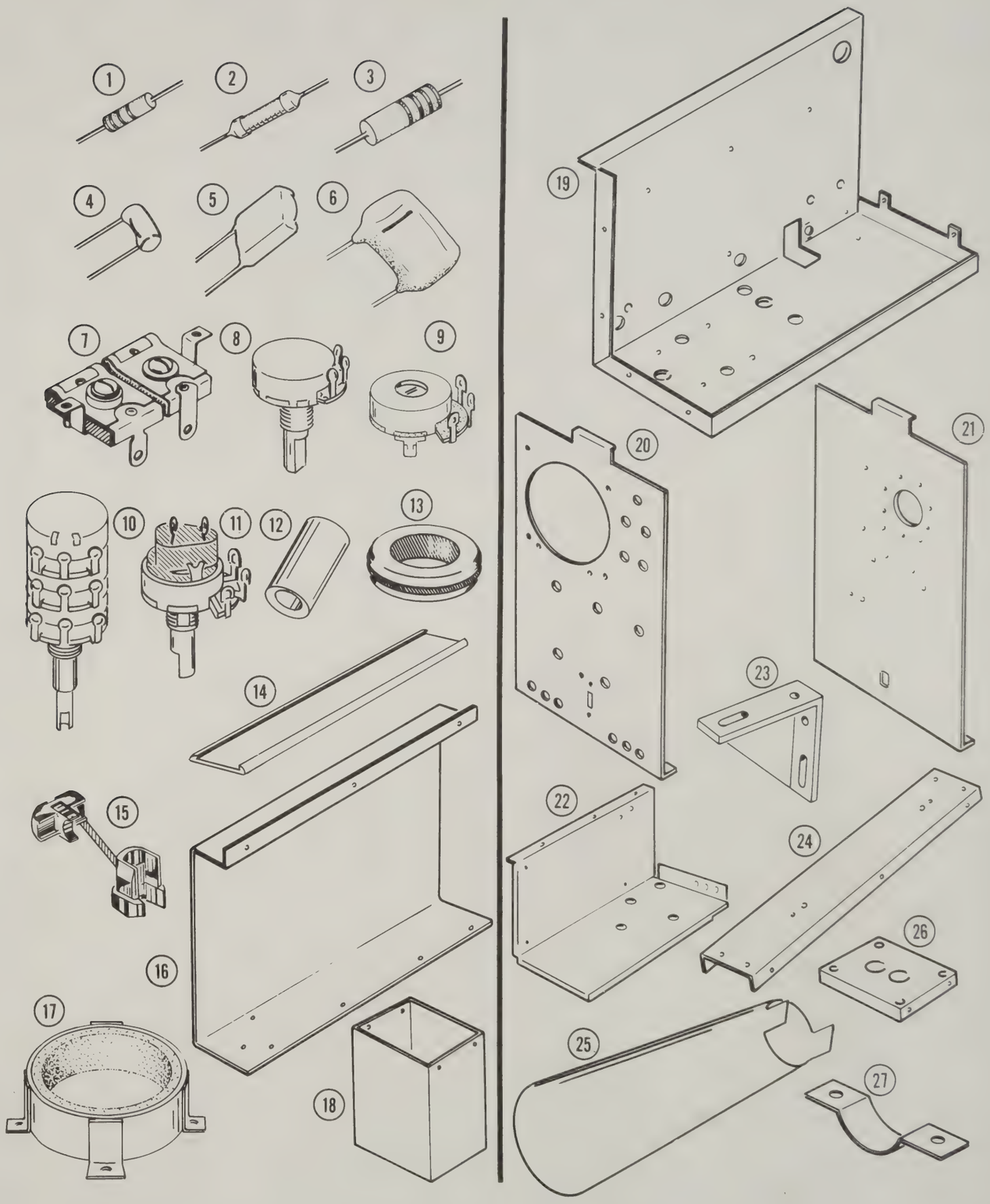
CHASSIS

PARTS LIST

Unpack package 5, which is all of the remaining parts, and check each part against the following list. The key numbers correspond to the numbers on the "Chassis Parts Pictorial" (fold-out from Page 31). Any part that is packaged in an individual envelope with a part number on it should be placed back in its envelope after it is identified until it is called for in a step.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS			
1/2-Watt, 10%			
1	1-26	1	100 kΩ (brown-black-yellow)
1	1-35	1	1 MΩ (brown-black-green)
1/2-Watt, 1%			
2	2-50	1	10 kΩ
2	2-41	1	90 kΩ
2	2-51	1	900 kΩ
1-Watt, 10%			
3	1-32-1	1	470 kΩ (yellow-violet-yellow)
CAPACITORS			
Mica			
4	20-100	1	30 pF
4	20-113	1	470 pF
Mylar			
5	27-77	1	.1 μF, 100 V
6	27-112	1	.1 μF, 600 V
Other Capacitor			
7	31-18	1	Dual trimmer
CONTROLS			
8	10-271	3	1000 Ω
8	10-224	1	1 MΩ
9	10-282	1	150 kΩ
10	13-9	1	Triple control
11	19-149	1	250 kΩ
INSULATORS			
12	70-5	1	Black insulator
12	70-6	1	Red insulator
13	73-2	6	Large rubber grommet
13	73-3	5	Small rubber grommet
14	73-5	1	Cushion strip
15	75-71	1	Line cord strain relief
METAL PARTS			
16	90-513-1	2	Cabinet shell
17	100-296	1	CRT ring
18	100-1046	1	Transformer side shield
19	200-598	1	Chassis
20	203-770-1	1	Front panel
21	203-771-1	1	Rear panel
22	204-1169	1	Circuit board mounting plate
23	204-1170	2	CRT mounting bracket
24	204-1171-1	1	Top bracket
25	206-304	1	Tube shield
26	206-518	1	Transformer top shield
27	207-1	2	CRT clamp

CHASSIS PARTS PICTORIAL

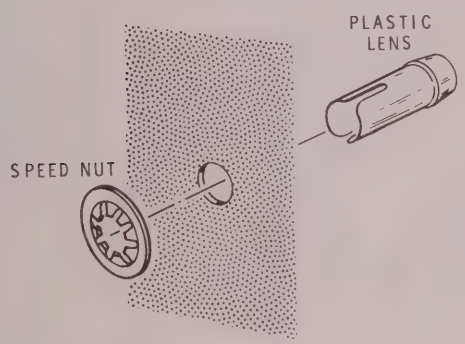


STEP-BY-STEP ASSEMBLY

FRONT PANEL PARTS MOUNTING

Refer to Pictorial 5-1 (fold-out from Page 32) for the following steps.

( ) Refer to Detail 5-1A and mount a plastic lens at AA as shown. Secure it in place by pushing the Speed Nut onto the plastic lens.



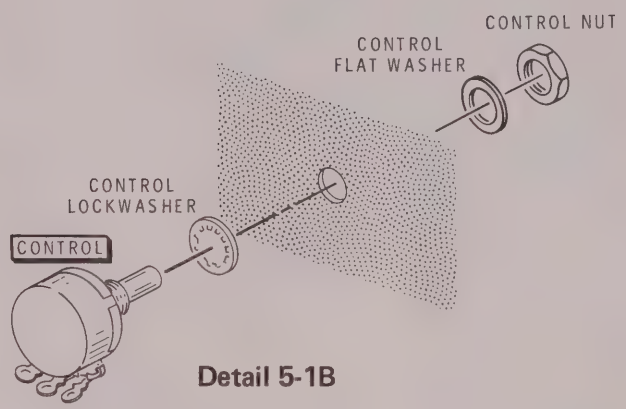
Detail 5-1A

Refer to Detail 5-1B for the following steps.

( ) Mount a 1 MΩ control (#10-224) at AB as shown. Use a control lockwasher, a control flat washer, and a control nut.

( ) Mount a 1000 Ω (1 k) control (#10-271) at AC as shown. Use a control lockwasher, a control flat washer, and a control nut.

( ) Mount a 1000 Ω (1 kΩ control (#10-271) at AD as shown. Use a control lockwasher, a control flat washer, and a control nut.



Detail 5-1B

Refer to Detail 5-1C for the following steps.

NOTE: When mounting the banana jacks in the following steps, use the nut supplied with the banana jack. After each jack is installed, bend the lug 90 degrees as shown in Pictorial 5-1.

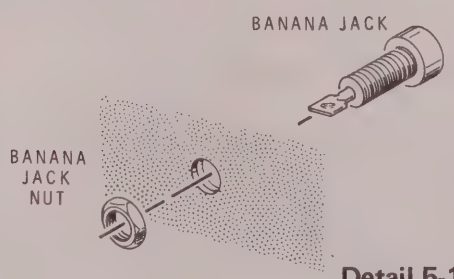
Mount the banana jacks as follows:

( ) Red banana jack at AE.

( ) Black banana jack at AF.

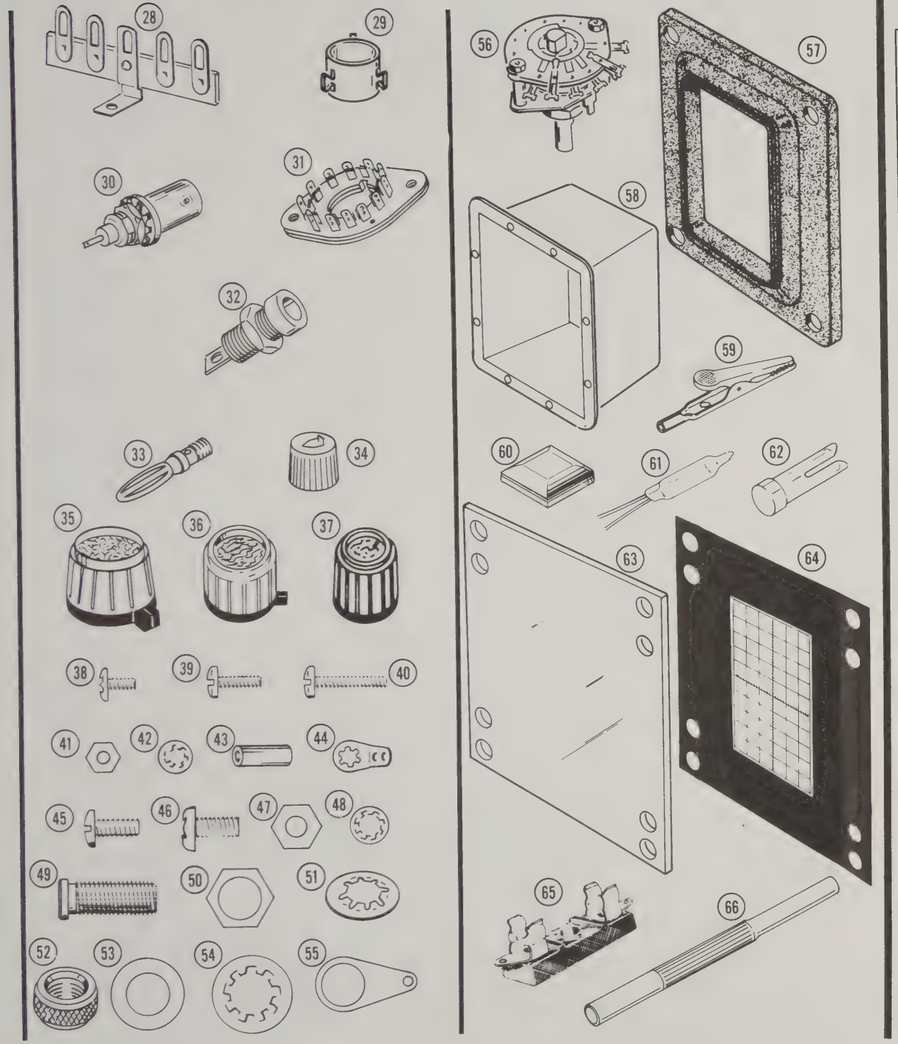
( ) Red banana jack at AG.

( ) Red banana jack at AH.

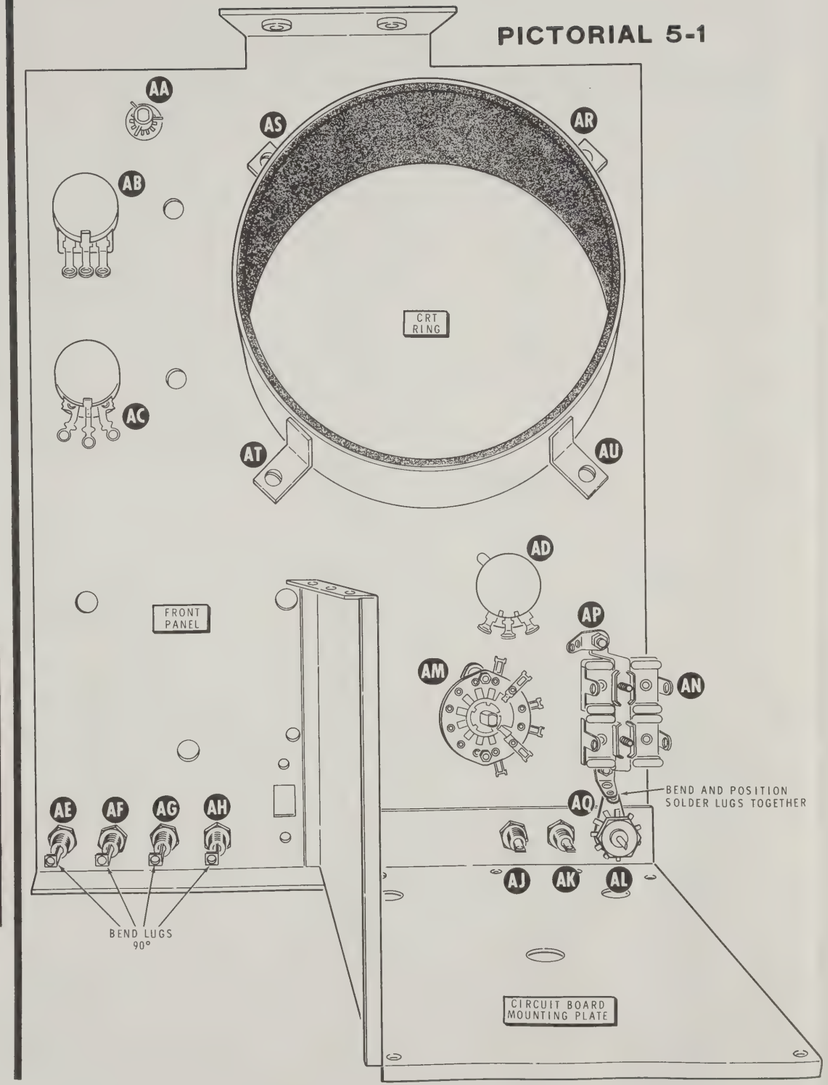


Detail 5-1C

CHASSIS PARTS PICTORIAL (Cont'd.)



PICTORIAL 5-1



TERMINAL STRIP-CONNECTOR-SOCKET

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
28	431-42	1	5-lug terminal strip
29	431-82	1	Terminal collar
30	432-59	1	BNC connector (with hardware)
31	434-41	1	Tube socket

JACKS-PLUGS

32	436-11	4	Red banana jack (with nut)
32	436-22	2	Black banana jack (with nut)
33	438-13	2	Banana plug

INSERTS-KNOBS

34	455-50	9	Knob insert
35	462-245	2	Large knob
36	462-248	3	Small knob with pointer
37	462-249	4	Small knob

HARDWARE

#6 Hardware

38	250-229	52	6-32 x 1/4" screw
39	250-89	1	6-32 x 3/8" screw
40	250-26	2	6-32 x 5/8" screw
41	252-3	17	6-32 nut
42	254-1	26	#6 lockwasher
43	255-94	6	1/2" spacer
44	259-1	5	#6 solder lug

#8 Hardware

45	250-137	4	8-32 x 3/8" screw

#10 Hardware

46	250-50	20	10-32 x 3/8" screw
47	252-5	6	10-32 nut
48	254-3	6	#10 lockwasher

Other Hardware

49	250-287	4	3/4" threaded stud
50	252-7	9	Control nut
51	252-73	1	Speed Nut*
52	252-86	4	Thumbnut
53	253-10	9	Control flat washer
54	254-4	7	Control lockwasher
55	259-27	1	Control solder lug

MISCELLANEOUS

	54-258	1	Power transformer
56	63-588	1	Rotary switch
	89-23	1	Line cord
	134-252	1	Wiring harness
57	210-48	1	Bezel
	211-49	1	Handle
58	214-117	1	Plastic housing
59	260-1	2	Alligator clip
60	261-28	4	Plastic foot
	341-1	1	Black test lead
	341-2	1	Red test lead
	390-362	1	Fuse label
	391-54	1	"Heathkit" nameplate
	411-265	1	5DEP1F tube
61	412-15	1	Neon lamp (NE-2H)
62	413-10	1	Plastic lens
63	414-10	1	Window
64	414-22	1	Graticule
	421-23	1	1 ampere, slow-blow fuse
65	422-1	1	Fuseholder
66	490-5	1	Nut starter
	391-34	1	Blue and white label
	597-260	1	Parts Order Form

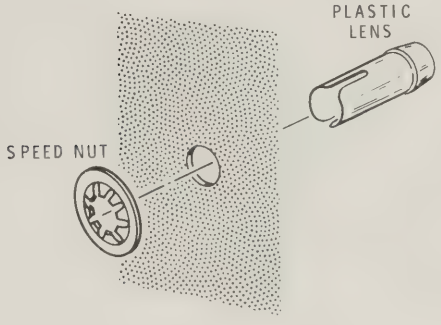
*Tinnerman Registered Trademark

STEP-BY-STEP ASSEMBLY

FRONT PANEL PARTS MOUNTING

Refer to Pictorial 5-1 (fold-out from Page 32) for the following steps.

( ) Refer to Detail 5-1A and mount a plastic lens at AA as shown. Secure it in place by pushing the Speed Nut onto the plastic lens.



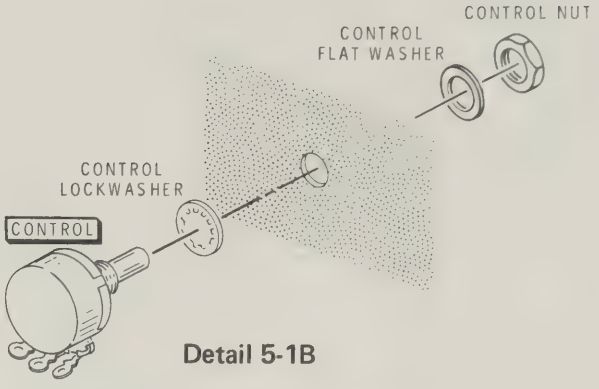
Detail 5-1A

Refer to Detail 5-1B for the following steps.

( ) Mount a 1 MΩ control (#10-224) at AB as shown. Use a control lockwasher, a control flat washer, and a control nut.

( ) Mount a 1000 Ω (1 k) control (#10-271) at AC as shown. Use a control lockwasher, a control flat washer, and a control nut.

( ) Mount a 1000 Ω (1 kΩ control (#10-271) at AD as shown. Use a control lockwasher, a control flat washer, and a control nut.



Detail 5-1B

Refer to Detail 5-1C for the following steps.

NOTE: When mounting the banana jacks in the following steps, use the nut supplied with the banana jack. After each jack is installed, bend the lug 90 degrees as shown in Pictorial 5-1.

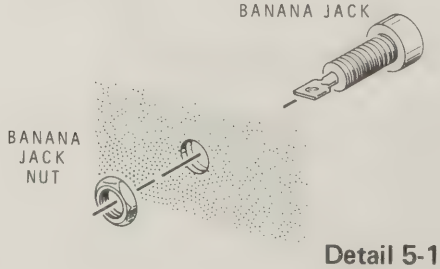
Mount the banana jacks as follows:

( ) Red banana jack at AE.

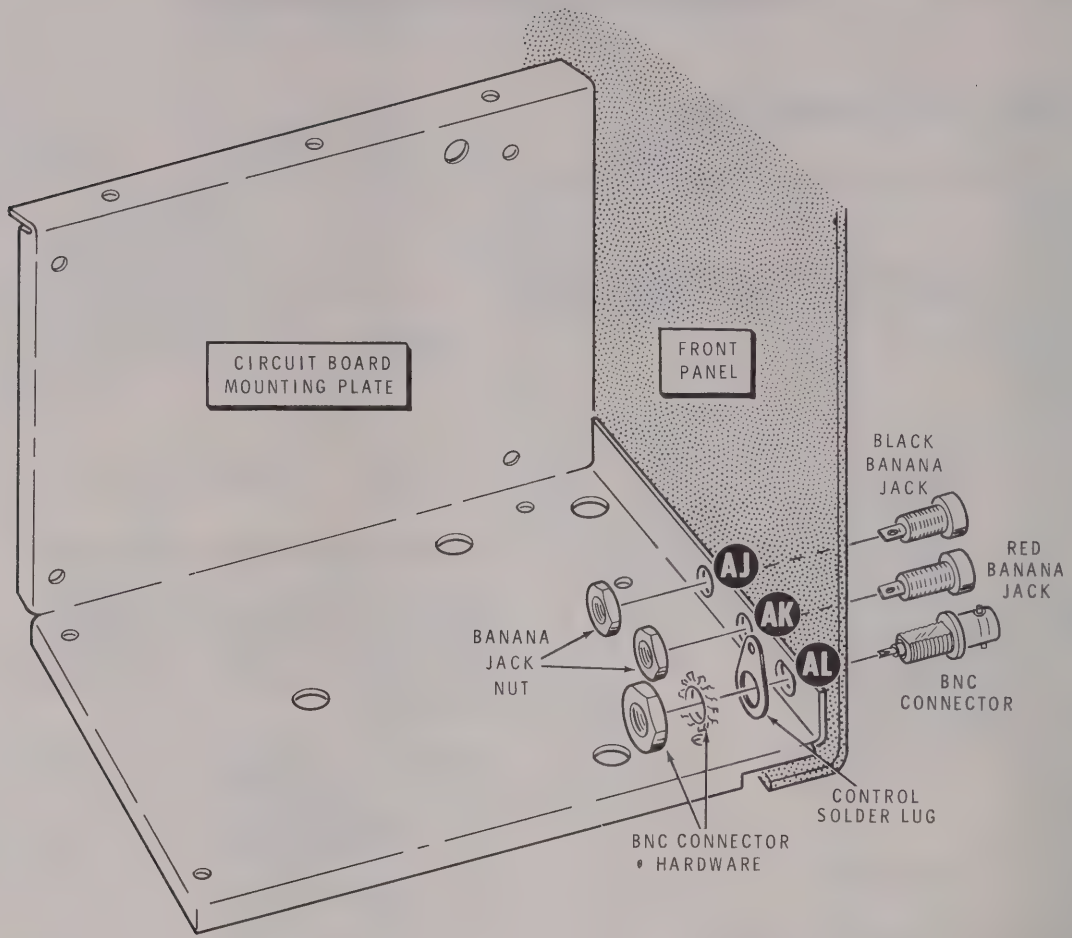
( ) Black banana jack at AF.

( ) Red banana jack at AG.

( ) Red banana jack at AH.



Detail 5-1C

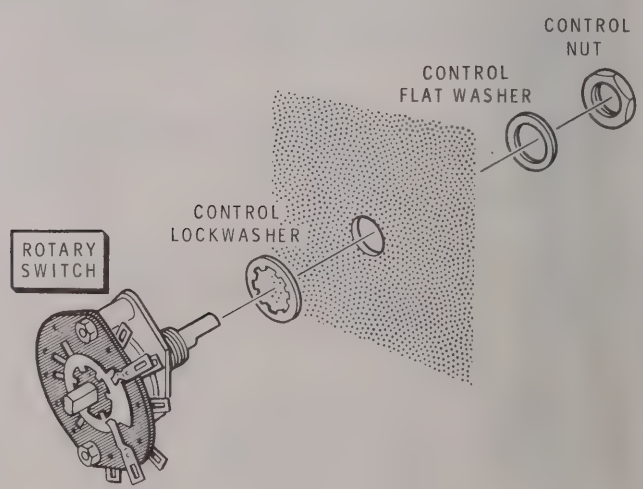


Detail 5-1D

Refer to Detail 5-1D for the following step.

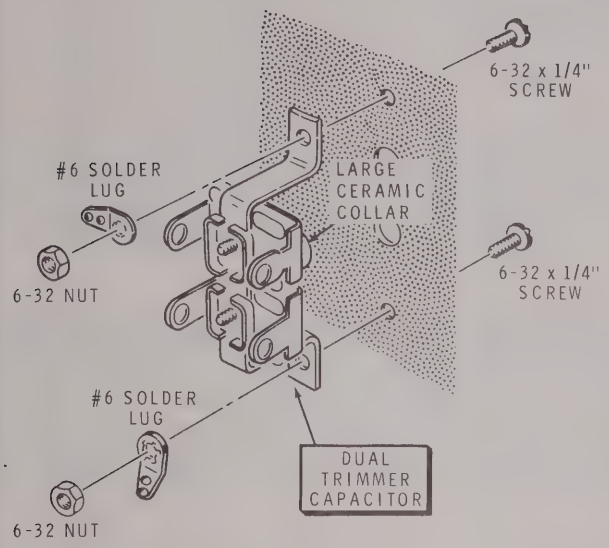
( ) Mount the circuit board mounting plate to the front panel with a black banana jack at AJ, a red banana jack at AK, and a BNC connector at AL. Use the hardware supplied with the banana jacks and the BNC connector. Also use a control solder lug with the BNC connector and bend it as shown in Pictorial 5-1.

( ) Refer to Detail 5-1E and mount the rotary switch at AM as shown. Use a control lockwasher, a control flat washer, and a control nut.

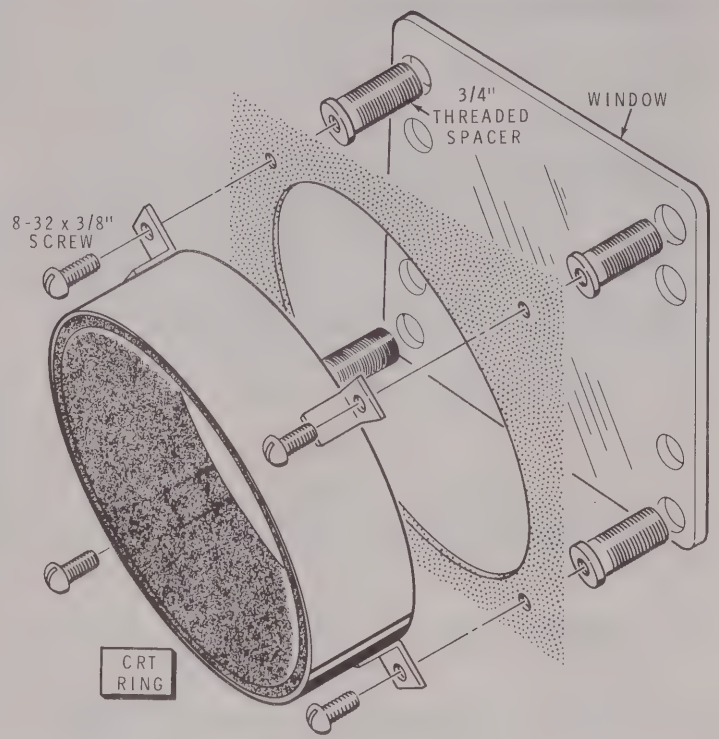


Detail 5-1E

NOTE: A plastic nut starter has been provided with this kit. Use this nut starter to hold and start 6-32 nuts on screws. Refer to the "Kit Builders Guide" for further information.



Detail 5-1F



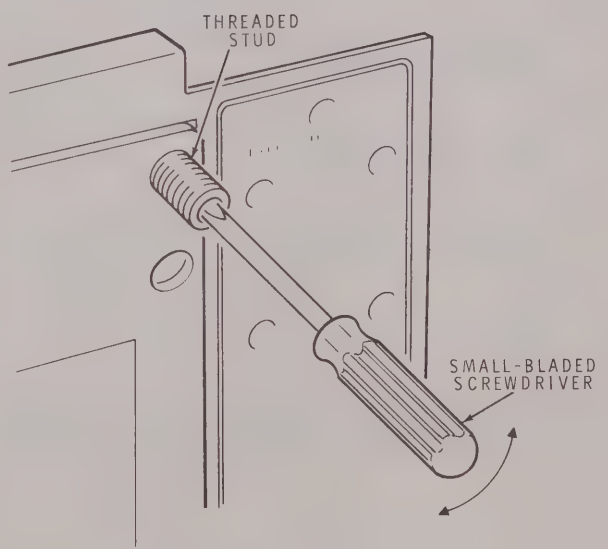
Detail 5-1G

( ) Refer to Detail 5-1F and mount a dual trimmer capacitor at AN with 6-32 x 1/4" hardware. Be sure the trimmer capacitor with the large ceramic collar is positioned as shown and the solder lugs at AP and AQ are positioned as shown.

( ) Refer to Detail 5-1G and mount the CRT ring and window onto the front panel. Use 8-32 x 3/8" screws and 3/4" threaded studs at AR, AS, AT, and AU. NOTE: Leave the 8-32 x 3/8" screws loose until the window is in place.

NOTE: In the following step you will be instructed to remove the window installed in the previous step. If the window does not easily slide back off the threaded studs, use a small-bladed screwdriver and carefully tilt the threaded studs in the direction necessary to allow free movement of the window. See Detail 5-1H.

( ) Remove the window and set it aside.



Detail 5-1H

FRONT PANEL WIRING

Refer to Pictorial 5-2 (fold-out from Page 41) for the following steps.

NOTE: When you are instructed to prepare lengths of wire ahead of time, as in the following step, use the white wire supplied with the kit. To prepare a wire, cut it to the indicated length; then remove 1/4" of insulation from each end. When bare wire is called for, cut the white wire to the indicated length; then remove all of the insulation.

( ) Prepare the following lengths of wire:

1"	1-1/2"
1"	1-1/2"

( ) Connect a 1" wire to the lug of red banana jack AE (S-1). Route the free end of this wire as shown.

( ) Connect a 1" wire to the lug of black banana jack AF (S-1). Route the free end of this wire as shown.

( ) Connect a 1-1/2" wire to the lug of red banana jack AG (S-1). Route the free end of this wire as shown.

( ) Connect a 1-1/2" wire to the lug of red banana jack AH (S-1). Route the free end of this wire as shown.

( ) Connect a 900 kΩ, 1% resistor between lugs 1 (NS) and 2 (NS) of capacitor AN.

( ) Connect a 90 kΩ, 1% resistor between lugs 2 (NS) and 3 (NS) of capacitor AN.

( ) Connect a 30 pF mica capacitor between lugs 2 (NS) and 3 (NS) of capacitor AN.

( ) Connect a 10 kΩ, 1% resistor between lugs 3 (NS) and 4 (NS) of capacitor AN.

( ) Connect a 470 pF mica capacitor between lugs 3 (NS) and 4 (NS) of capacitor AN.

( ) Prepare the following lengths of wire:

1-1/2" bare	1-1/4"
1-3/4"	1-1/2"
1-3/8"	2-1/2"
2"	2-1/4" bare

( ) Insert one end of a 1-1/2" bare wire through lug 12 of switch AM (NS) to the frame of the switch (S-1). (See the inset drawing.) Connect the other end of this wire to lug 3 of control AD (NS).

NOTE: When a wire passes through a connection and then goes to another point, it will count as two wires in the soldering instructions (S-2), one entering and one leaving the connection. If another wire is added to the connection, as in the next step, they will count as three wires in the soldering instruction. (S-3).

( ) Connect a 1-3/4" wire from lug 12 of switch AM (S-3) to solder lug AP (S-1).

( ) Cut both leads of a .1 μF 600 V, Mylar capacitor to 1/2".

( ) Connect the capacitor between lug 8 (NS) and both lugs 11 (front and rear of wafer) (NS) of switch AM. Position the capacitor against the front panel as shown.

( ) Connect a 1-3/8" wire from lug 1 of capacitor AN (S-2) to both lugs 11 (front and rear of wafer) of switch AM (S-2).

( ) Connect a 2" wire from lug 2 of capacitor AN (S-4) to lug 10 of switch AM S-1).

( ) Connect a 1-1/4" wire from lug 3 of capacitor AN (S-5) to lug 9 of switch AM (S-1).

( ) Connect a 1-1/2" wire from lug 4 of capacitor AN (S-3) to solder lug AQ (NS).

( ) Connect a 2-1/2" wire from the lug of black banana jack AJ (NS) to solder lug AQ (S-2). NOTE: Also be sure that solder lug AQ is soldered to the solder lug of BNC connector AL. Route the white wire near the chassis as shown.

( ) Insert one end of a 2-1/4" bare wire through the lug of red banana jack AK (S-2) to the lug of the BNC connector AL (S-1). Connect the other end of this wire to lug 8 of switch AM (S-2).

Refer to Detail 5-2A for the following five steps. The Detail is divided into parts, and each step will refer to the pertinent part.

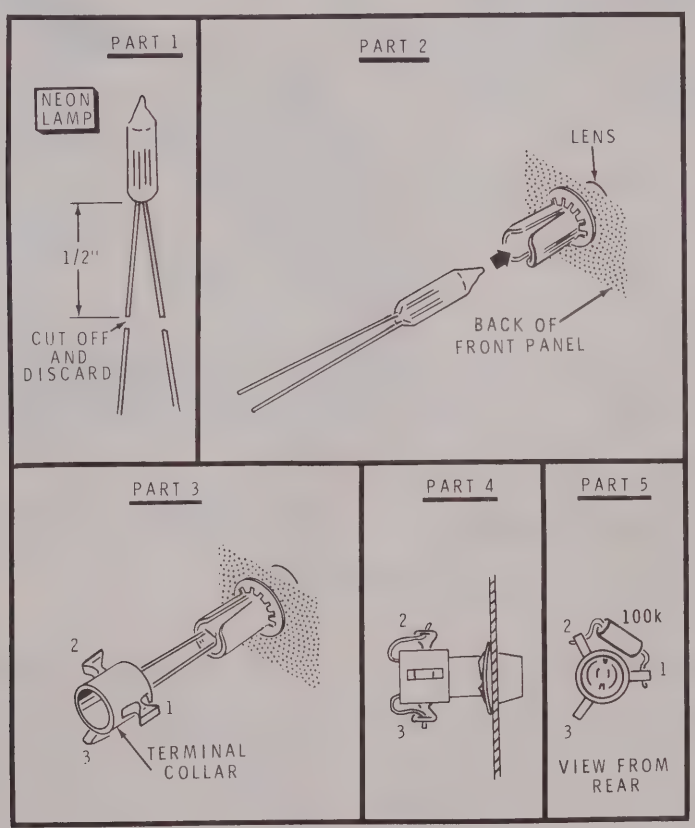
( ) Refer to Part 1 and cut the leads of the neon lamp to a length of 1/2".

( ) Refer to Part 2 and insert the lamp as far as it will go into the lens at AA.

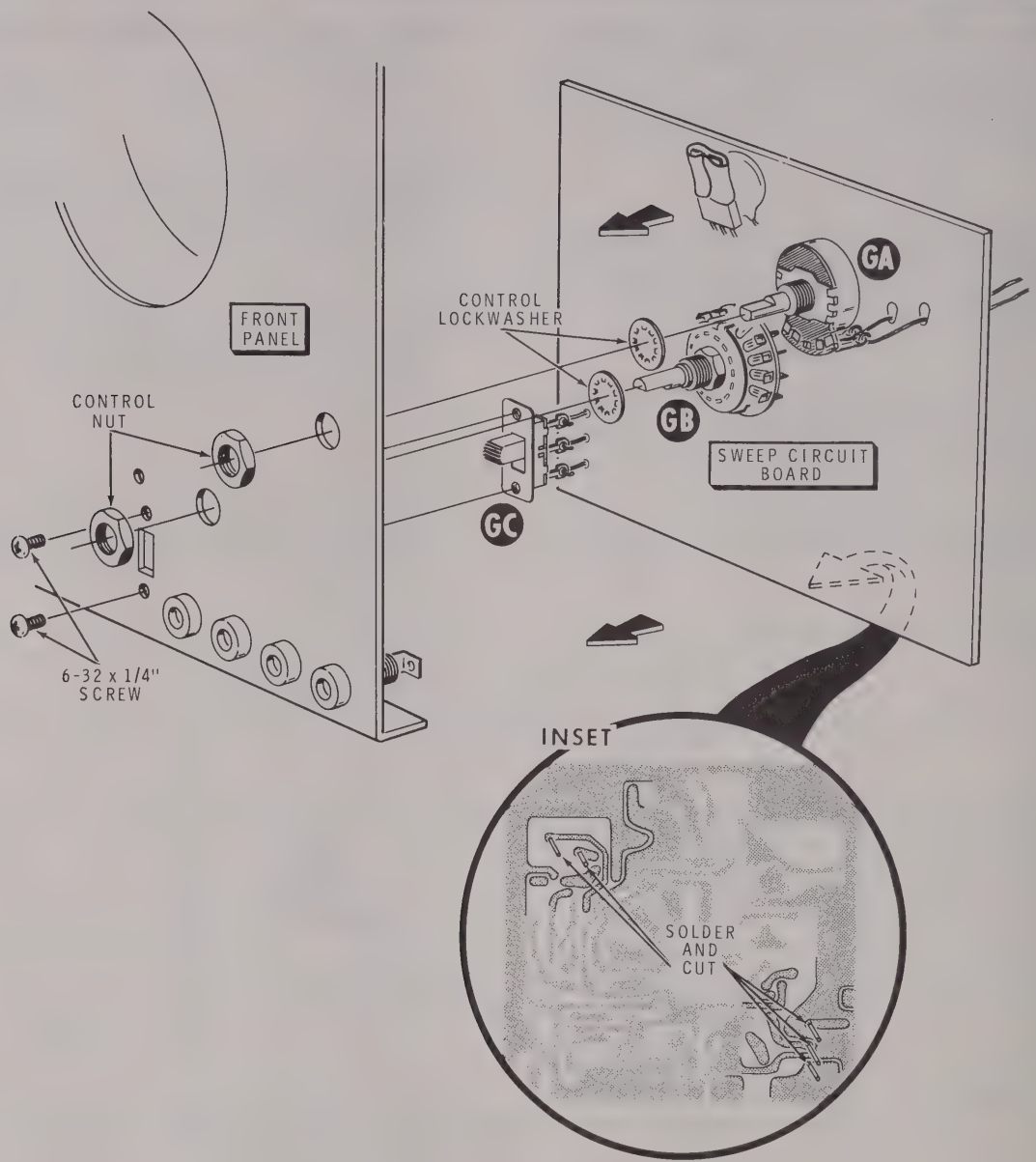
( ) Position the terminal collar as shown in the Pictorial, and push the collar onto the lens until the ends of the collar and lens are flush with each other as shown in Part 4.

( ) Refer to Part 4 and connect one lamp lead to lug 2 (NS) and the other lamp lead to lug 3 (NS) of the terminal collar.

( ) Refer to Part 5 and connect a 100 kΩ (brown-black-yellow) resistor between lug 1 (NS) and lug 2 (S-2) of the terminal collar. Cut off any excess lead lengths.



Detail 5-2A



PICTORIAL 5-3

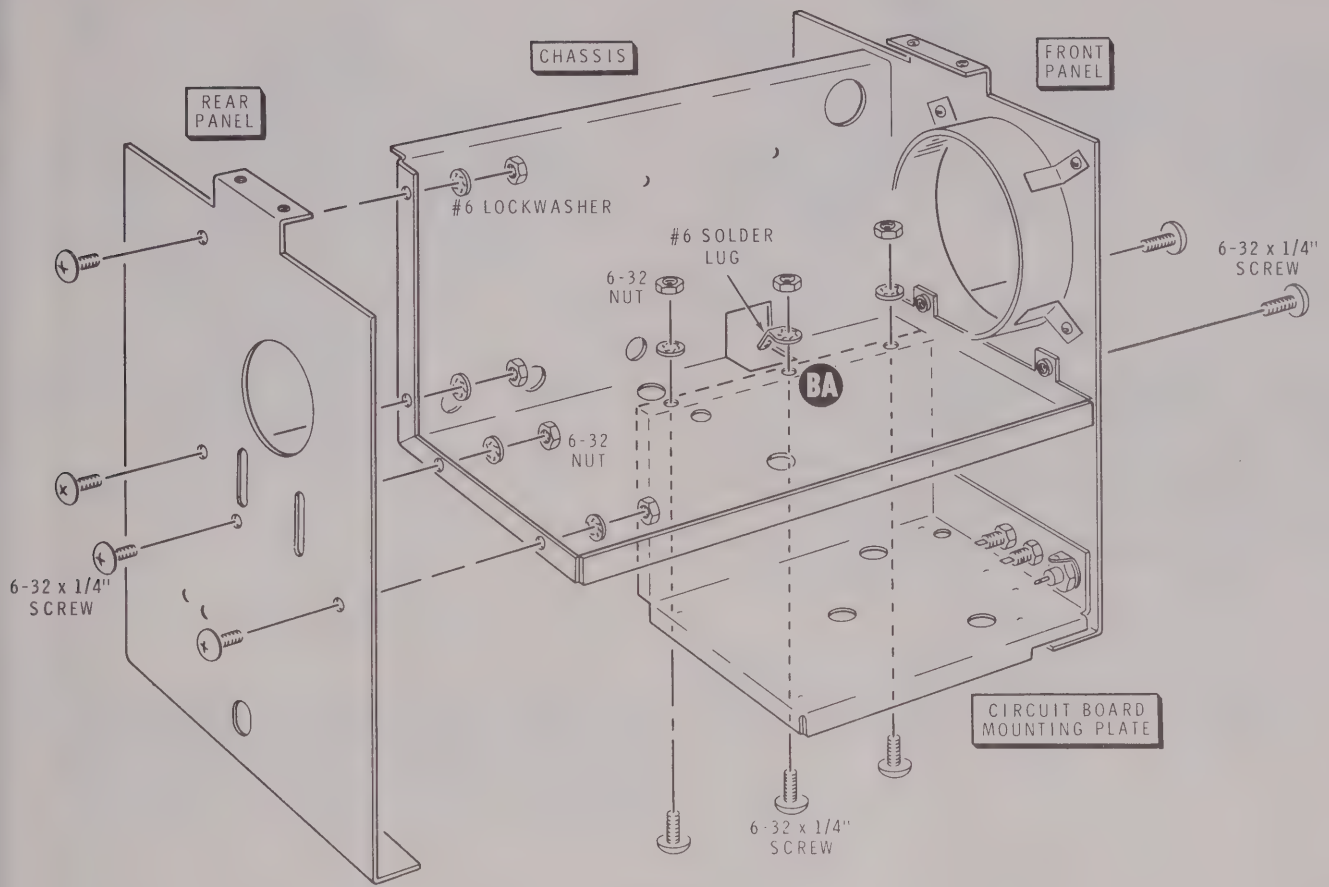
Refer to Pictorial 5-3 for the following steps.

( ) Locate the assembled sweep circuit board.

( ) Place control lockwashers on control GA and rotary switch GB.

( ) Position the sweep circuit board near the front panel so that the shafts of control GA and rotary switch GB and the knob of slide switch GC protrude through the front panel. Position the circuit board wires back out of the way and then temporarily mount the two switches and control with two control nuts and two 6-32 x 1/4" screws as shown.

( ) Carefully position the wires from control GA and slide switch GC so that the wire lengths to the circuit board are as short as possible. NOTE: Be careful not to bend the circuit board.



Detail 5-4A

( ) Solder the five wires (from control GA and switch GB) to the circuit board and cut off the excess wire lengths. See the inset drawing.

( ) Remove the two control nuts, two 6-32 x 1/4" screws, and two control lockwashers from control GA and switches GB and GC and set the sweep circuit board aside.

CHASSIS PARTS MOUNTING

Refer to Pictorial 5-4 (fold-out from Page 41) for the following steps.

( ) Refer to Detail 5-4A and fasten the chassis to the front panel and circuit board mounting plate. Use 6-32 x 1/4" hardware. Be sure the #6 solder lug at BA is positioned as shown.

( ) Fasten the rear panel to the chassis as shown in Detail 5-4A. Use 6-32 x 1/4" hardware.

Install rubber grommets to the chassis at the following locations:

( ) Small rubber grommet at BB.

( ) Large rubber grommet at BC.

( ) Small rubber grommet at BD.

( ) Large rubber grommet at BE.

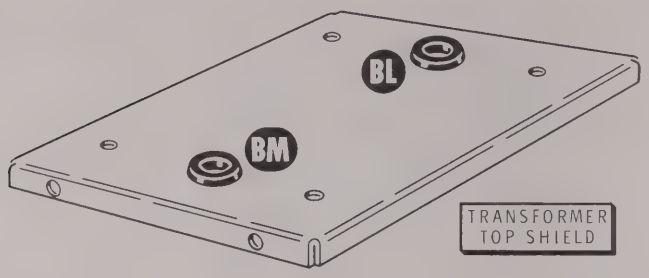
( ) Large rubber grommet at BF.

( ) Large rubber grommet at BG.

( ) Small rubber grommet at BH.

( ) Large rubber grommet at BJ.

( ) Large rubber grommet at BK.



Detail 5-4B

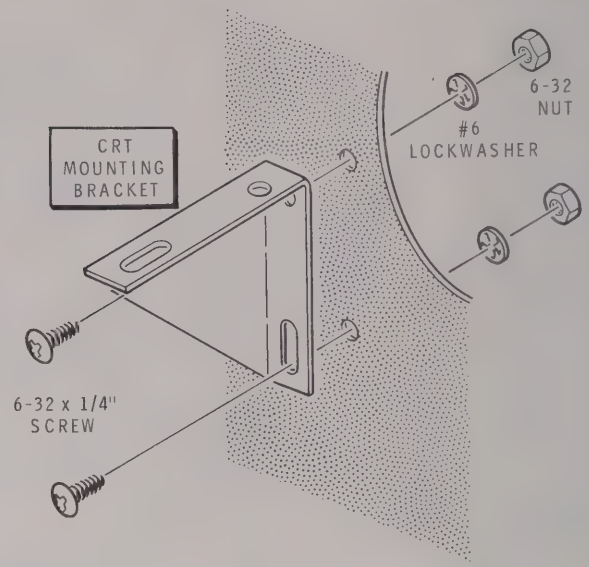
Refer to Detail 5-4B for the following steps.

( ) Locate the transformer top shield and install a small rubber grommet at BL.

( ) Install another small rubber grommet at BM.

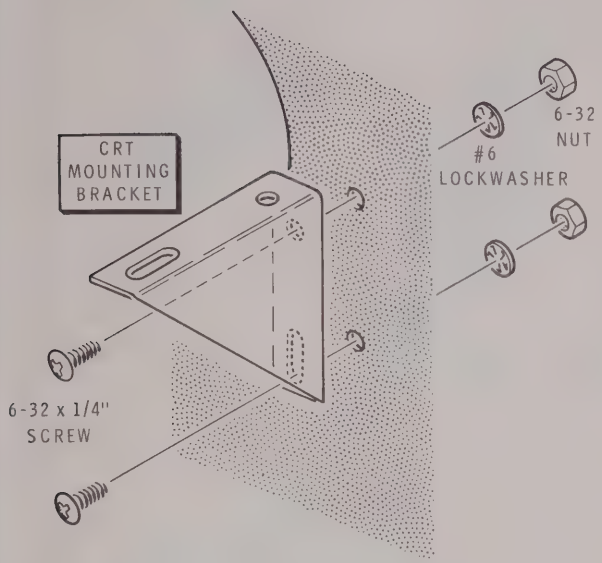
( ) Set the top shield aside.

( ) Refer to Detail 5-4C and mount a CRT mounting bracket at CA on the rear panel. Use 6-32 x 1/4" hardware.

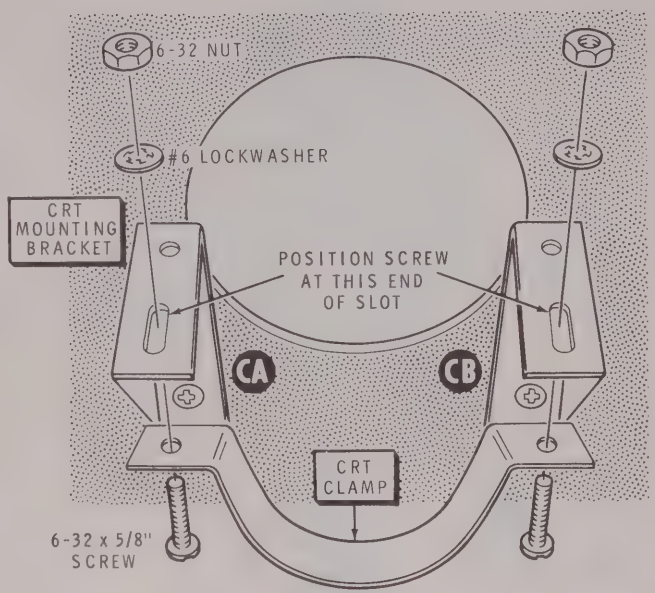


Detail 5-4C

( ) Refer to Detail 5-4D and mount another CRT mounting bracket at CB. Use 6-32 x 1/4" hardware.

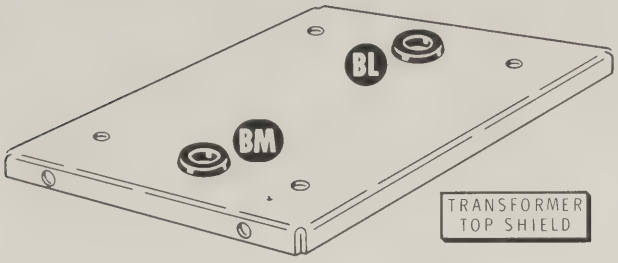


Detail 5-4D



Detail 5-4E

( ) Refer to Detail 5-4E and fasten a CRT clamp to the CRT mounting brackets. Use 6-32 x 5/8" hardware and position the screws at the indicated end of the slots as shown. NOTE: Only tighten the hardware finger tight.



Detail 5-4B

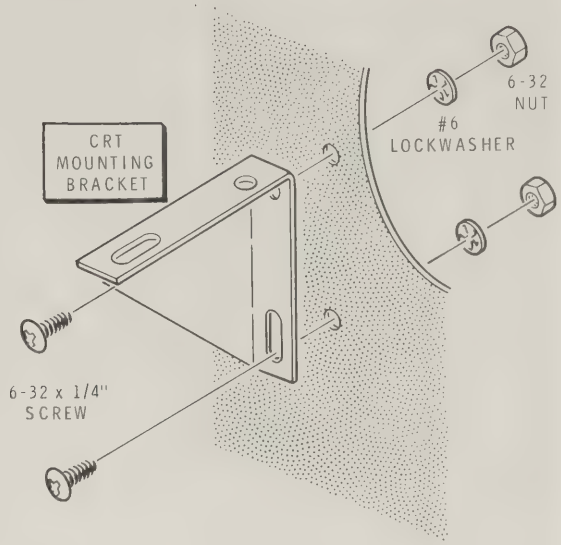
Refer to Detail 5-4B for the following steps.

( ) Locate the transformer top shield and install a small rubber grommet at BL.

( ) Install another small rubber grommet at BM.

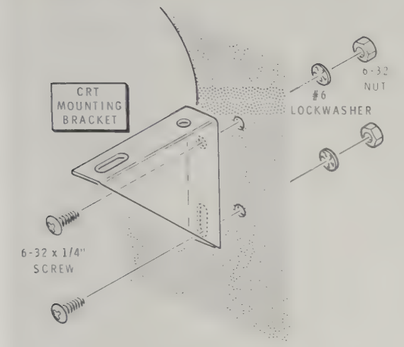
( ) Set the top shield aside.

( ) Refer to Detail 5-4C and mount a CRT mounting bracket at CA on the rear panel. Use 6-32 x 1/4" hardware.

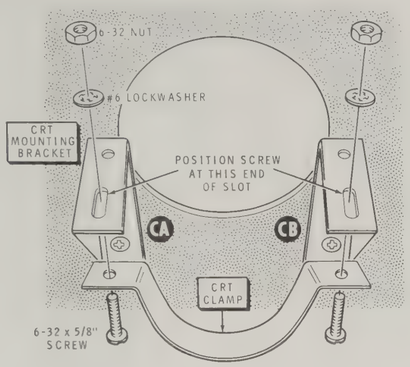


Detail 5-4C

( ) Refer to Detail 5-4D and mount another CRT mounting bracket at CB. Use 6-32 x 1/4" hardware.

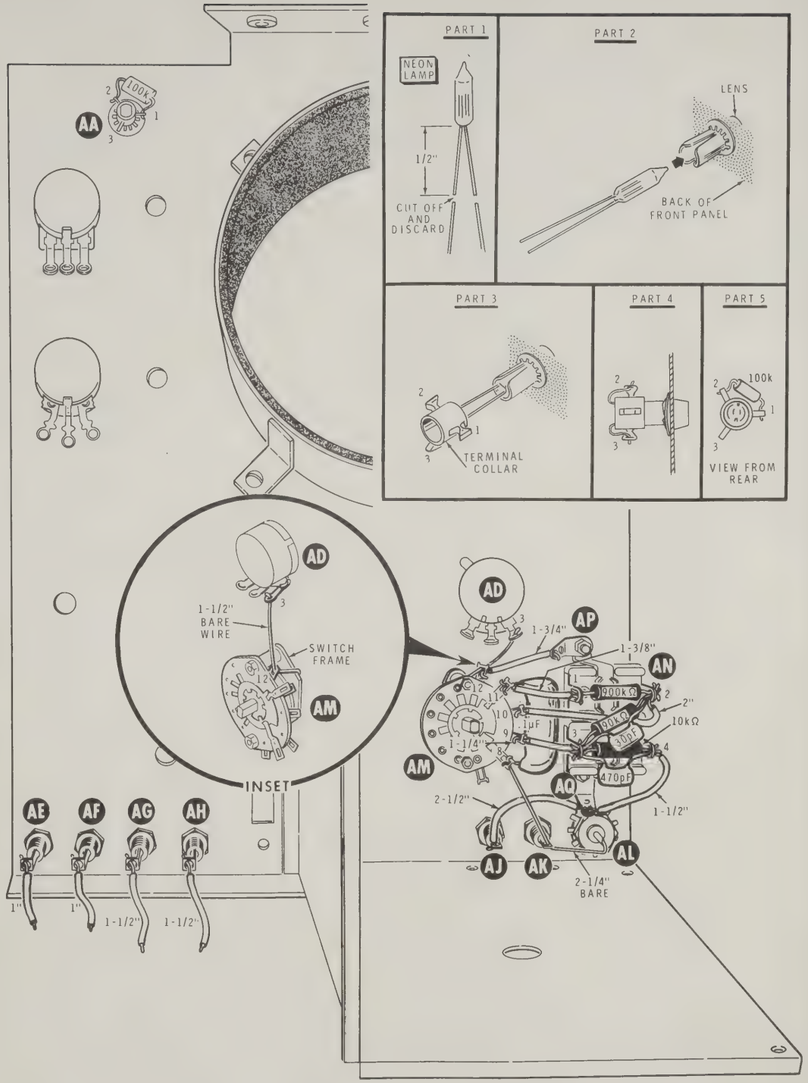


Detail 5-4D

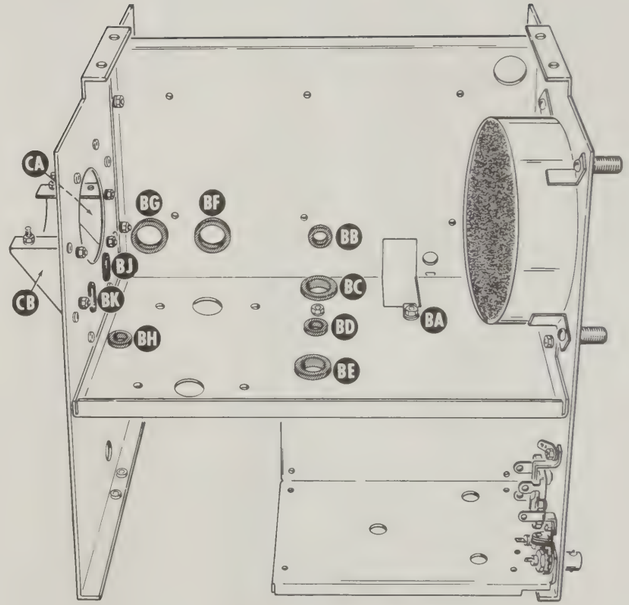


Detail 5-4E

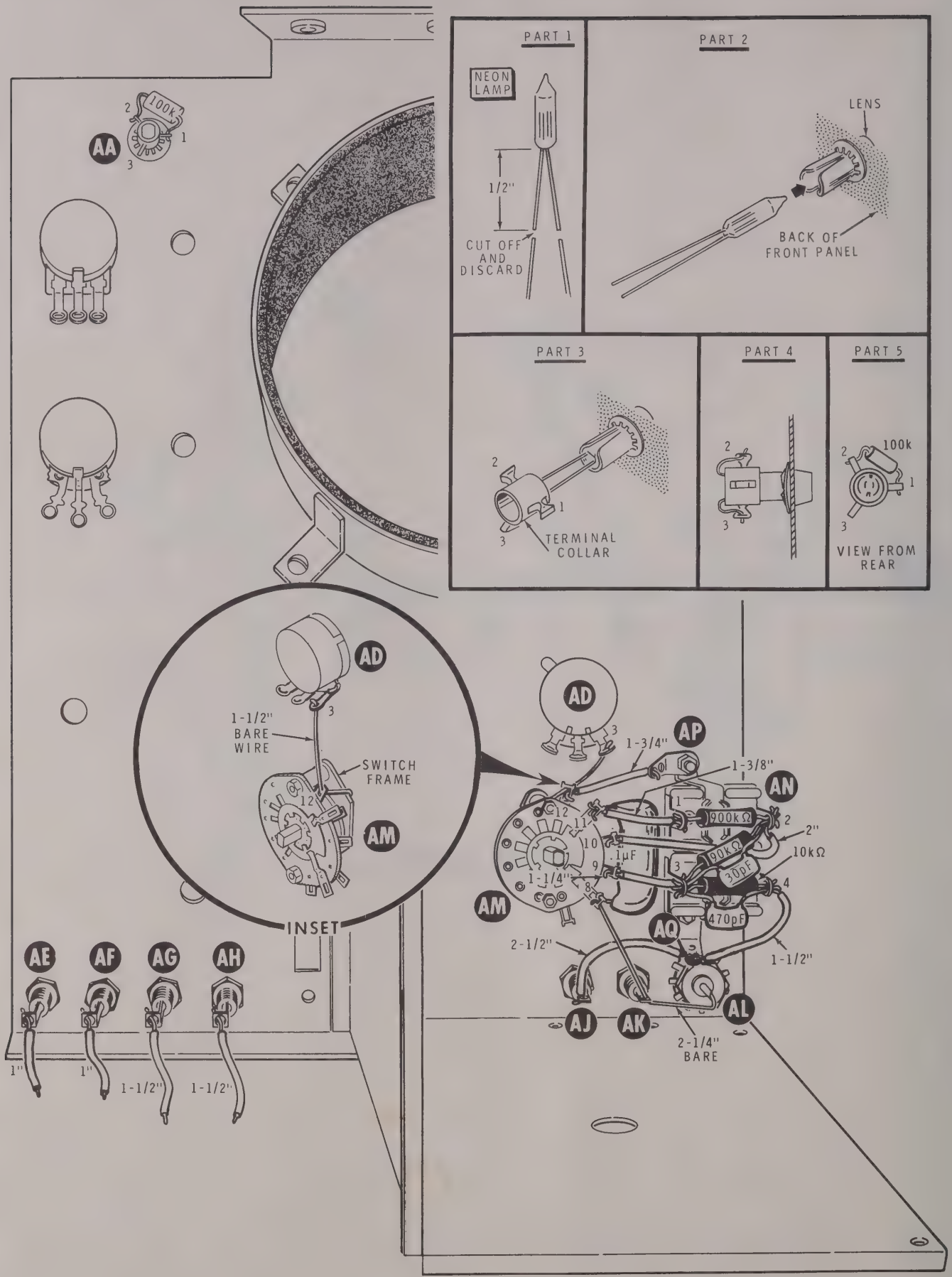
( ) Refer to Detail 5-4E and fasten a CRT clamp to the CRT mounting brackets. Use 6-32 x 5/8" hardware and position the screws at the indicated end of the slots as shown. NOTE: Only tighten the hardware finger tight.



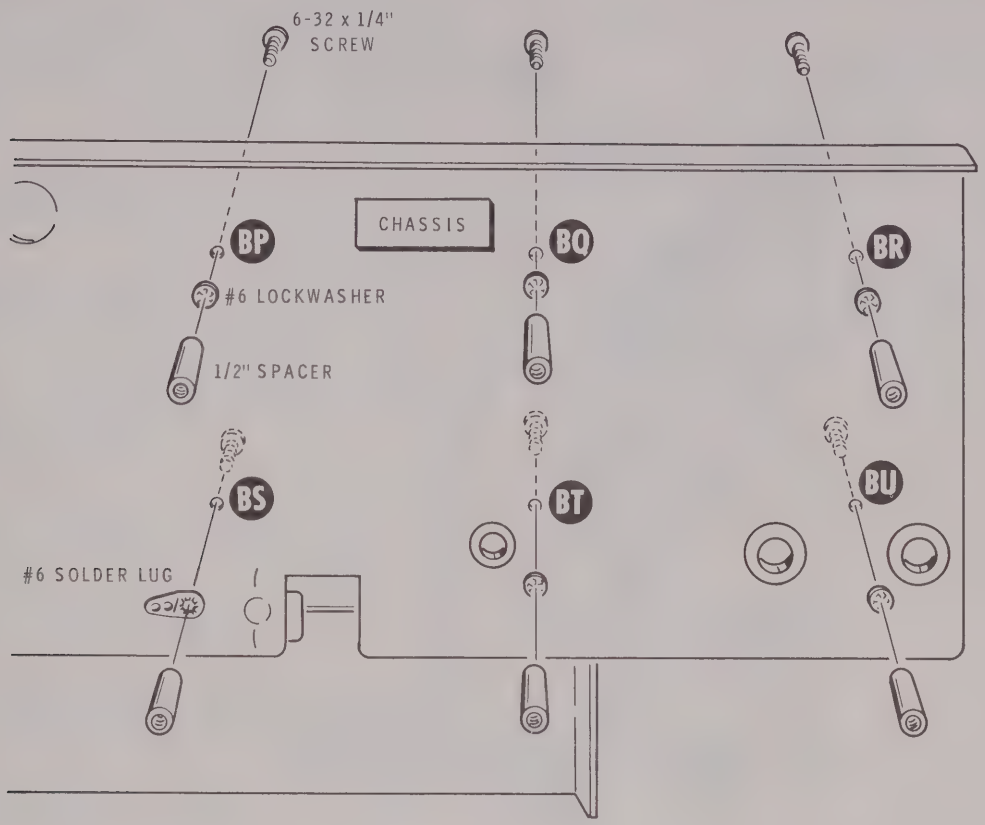
PICTORIAL 5-2



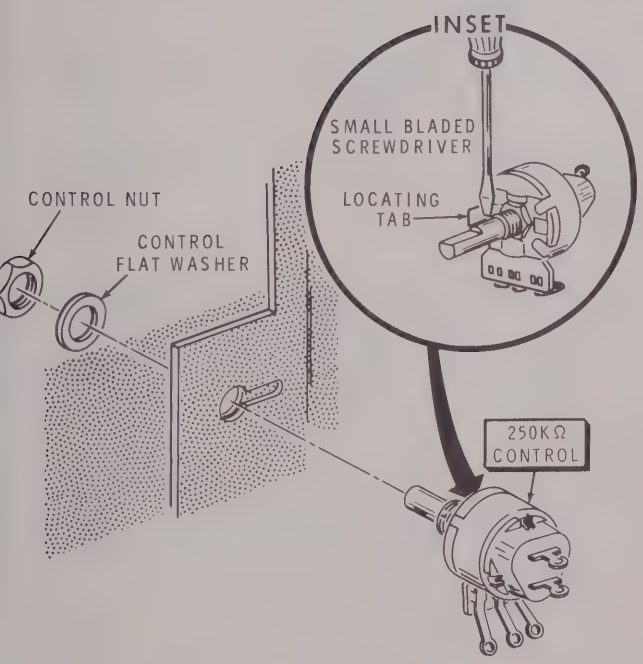
PICTORIAL 5-4



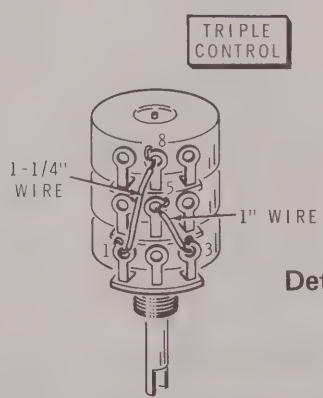
PICTORIAL 5-2



Detail 5-5D



Detail 5-5E



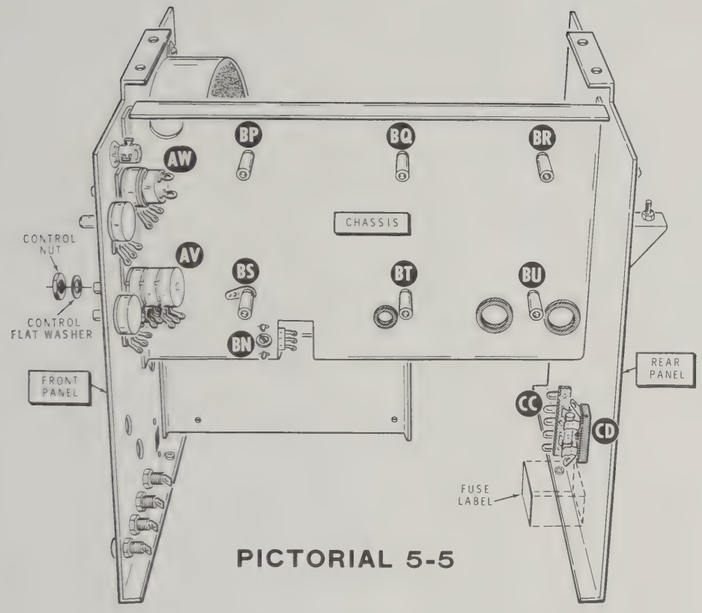
Detail 5-5F

Refer to Detail 5-5F for the following steps.

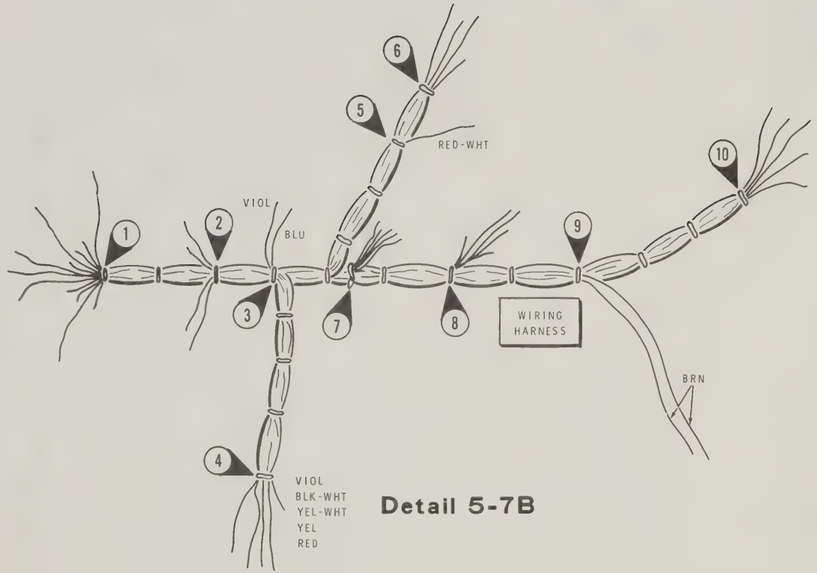
( ) Connect a 1-1/4" wire between lugs 1 (S-1) and 8 (S-1) of the triple (#13-9) control.

( ) Connect a 1" wire between lugs 3 (S-1) and 5 (S-1) of the triple control.

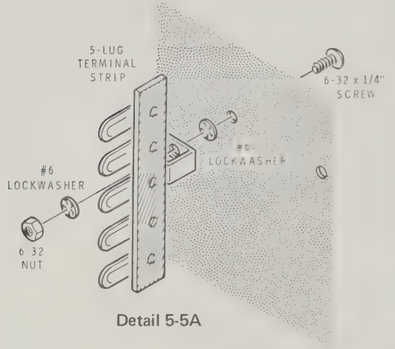
( ) Mount the triple control at AV on the front panel. Use a control flat washer and a control nut as shown in Pictorial 5-5.



PICTORIAL 5-5



Detail 5-7B

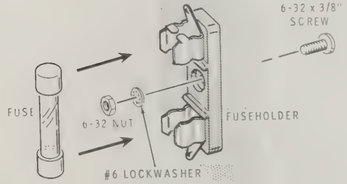


Detail 5-5A

Refer to Pictorial 5-5 (fold-out from Page 42) for the following steps.

( ) Refer to Detail 5-5A and mount a 5-lug terminal strip at CC on the rear panel as shown. Use 6-32 x 1/4" hardware.

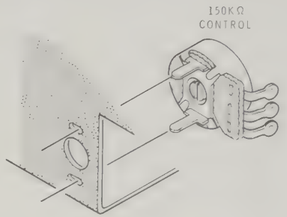
Refer to Detail 5-5B for the following steps.

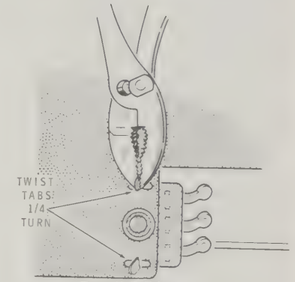


Detail 5-5B

( ) Mount a fuseholder at CD on the rear panel. Use 6-32 x 3/8" hardware.

NOTE: Later on, two sets of voltage wiring instructions will be given, one for 120 Vac and the other for 240 Vac. (In the United States, 120 Vac is most often used.) In the following step you will be instructed to install a fuse. If you intend to wire your Oscilloscope for 120 Vac operation, install the 1-ampere, slow-blow fuse supplied. However, if you intend to wire your Oscilloscope for 240 Vac operation, install a 1/2-ampere, slow-blow fuse (not supplied).





Detail 5-5C

( ) Install a fuse into fuseholder CD.

( ) Carefully peel away the backing paper from the fuse label. Then press the label onto the rear panel in the position shown. See Pictorial 5-5.

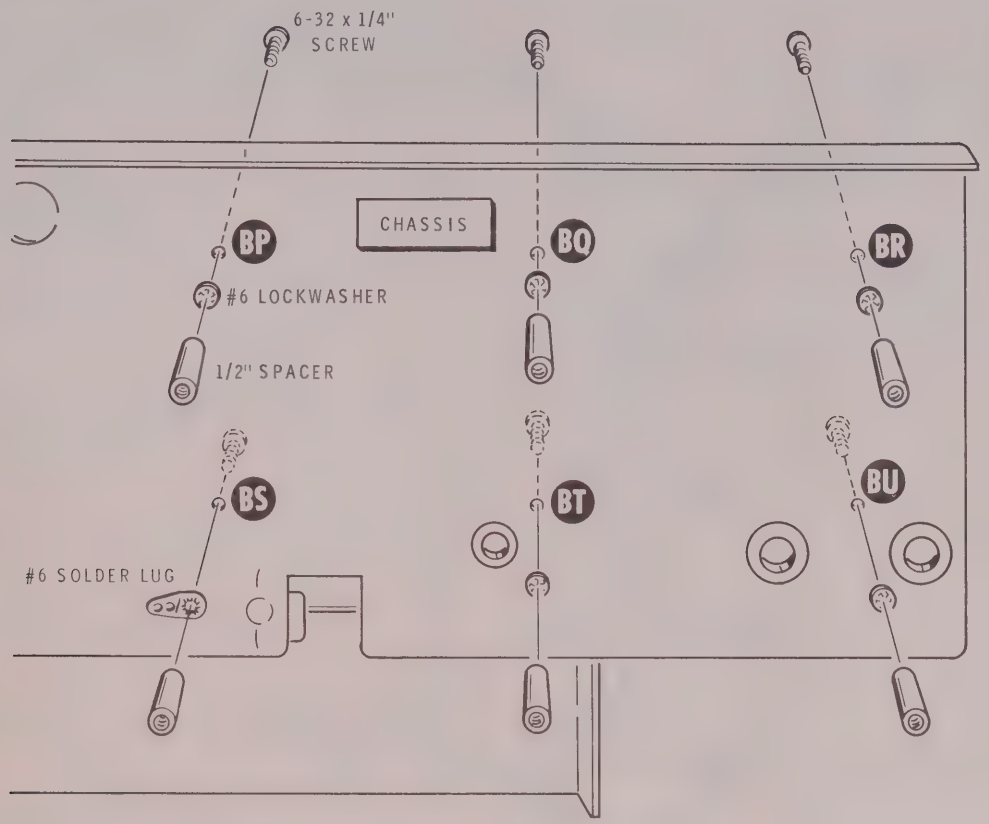
( ) Refer to Detail 5-5C and install a 150 kΩ control (#10-282) at BN on the chassis as shown.

( ) Refer to Detail 5-5D and fasten 1/2" spacers to the chassis at BP, BQ, BR, BS, BT, and BU. Use 6-32 x 1/4" hardware and be sure the #6 solder lug at BS is positioned as shown.

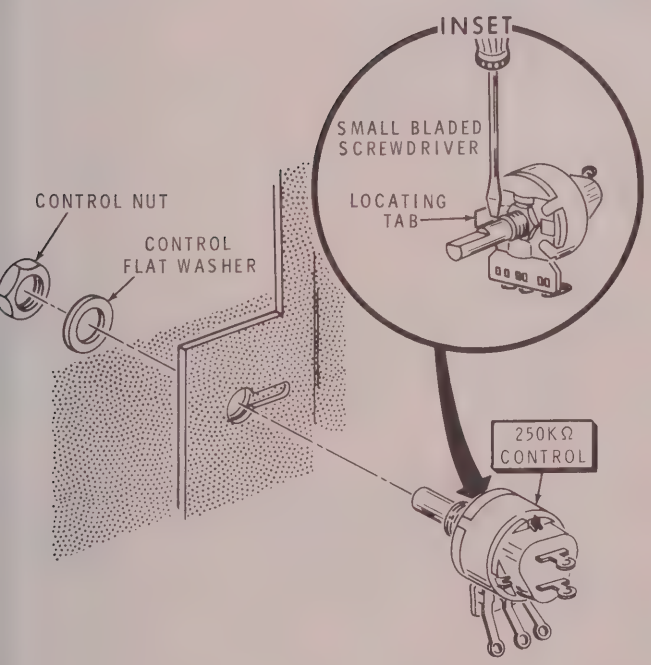
( ) Refer to Detail 5-5E and install a 250 kΩ control (#19-149) at AW on the front panel, as shown. Use a control flat washer and a control nut. NOTE: If the indicated locating tab of this control is not positioned as shown in the inset drawing, use a small-bladed screwdriver to bend it up as shown.

( ) Prepare the following lengths of wire:

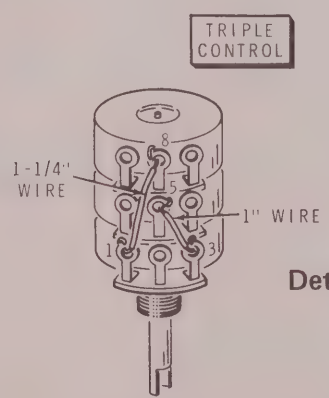
1-1/4"
1"



Detail 5-5D



Detail 5-5E



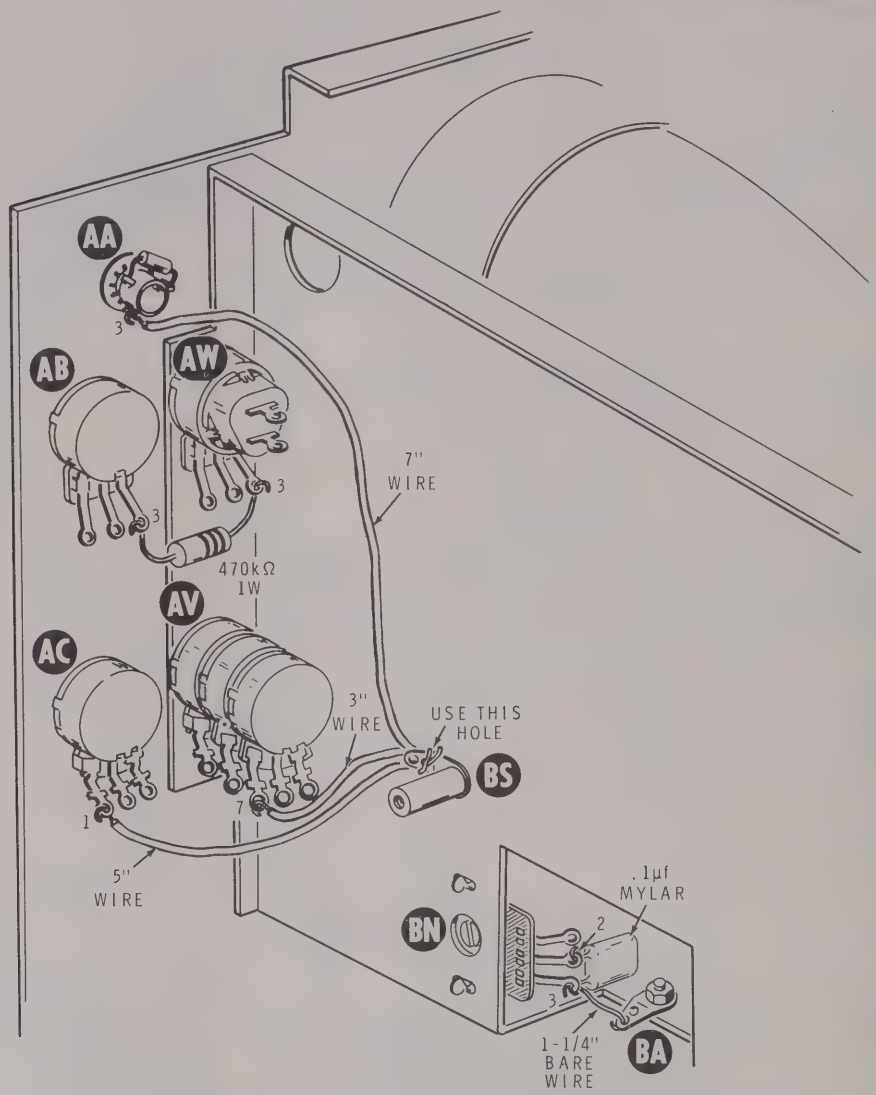
Detail 5-5F

Refer to Detail 5-5F for the following steps.

( ) Connect a 1-1/4" wire between lugs 1 (S-1) and 8 (S-1) of the triple (#13-9) control.

( ) Connect a 1" wire between lugs 3 (S-1) and 5 (S-1) of the triple control.

( ) Mount the triple control at AV on the front panel. Use a control flat washer and a control nut as shown in Pictorial 5-5.



PICTORIAL 5-6

CHASSIS WIRING

Refer to Pictorial 5-6 for the following steps.

( ) Prepare the following lengths of wire:

7"
3"
5"
1-1/4" bare

( ) Connect a 7" wire from lug 3 of terminal collar AA (S-2) to solder lug BS (NS). NOTE: Use the hole in the solder lug that is nearest the chassis and route the wire as shown.

( ) Connect a 3" wire from lug 7 of control AV (S-1) to solder lug BS (NS). NOTE: Use the hole in the solder lug that is nearest the chassis and route the wire as shown.

( ) Connect a 5" wire from lug 1 of control AC (S-1) to solder lug BS (S-3). NOTE: Use the hole in the solder lug that is nearest the chassis and do not allow solder to run into the other hole of the solder lug. Route the wire as shown.

( ) Connect a 1-1/4" bare wire from solder lug BA (NS) to lug 3 of control BN (NS).

( ) Connect a .1 μF Mylar capacitor between lugs 3 (S-2) and 2 (NS) of control BN.

( ) Connect a 470 kΩ, 1-watt resistor (yellow-violet-yellow) from lug 3 of control AB (S-1) to lug 3 of control AW (S-1).

Refer to Pictorial 5-7 (fold-out from Page 49) for the following steps.

Refer to Detail 5-7A for the following steps.

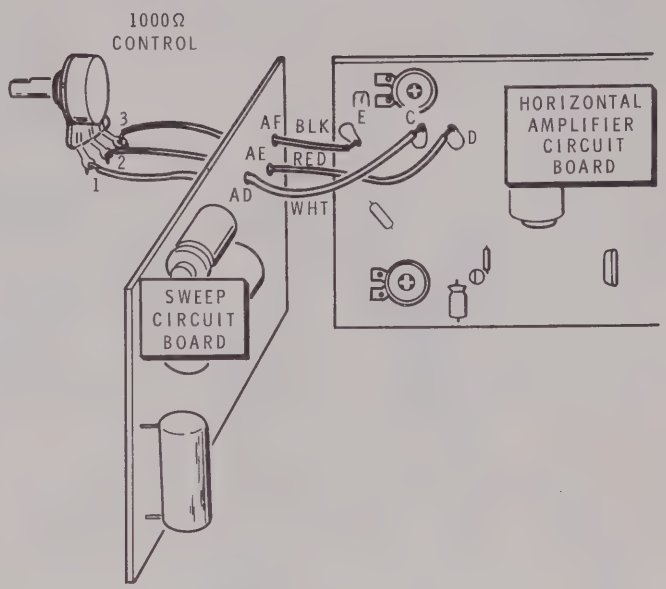
( ) Position the sweep circuit board and horizontal amplifier circuit board as shown in the Detail.

Route three wires coming from the horizontal circuit board through the sweep circuit board as follows:

( ) Route the black wire coming from hole E through hole AF.

( ) Route the red wire coming from hole D through hole AE.

( ) Route the white wire coming from hole C through hole AD.



Detail 5-7A

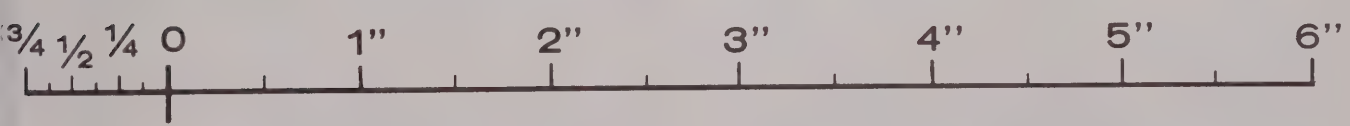
Connect these three wires to a 1000 Ω control (#10-271) as follows:

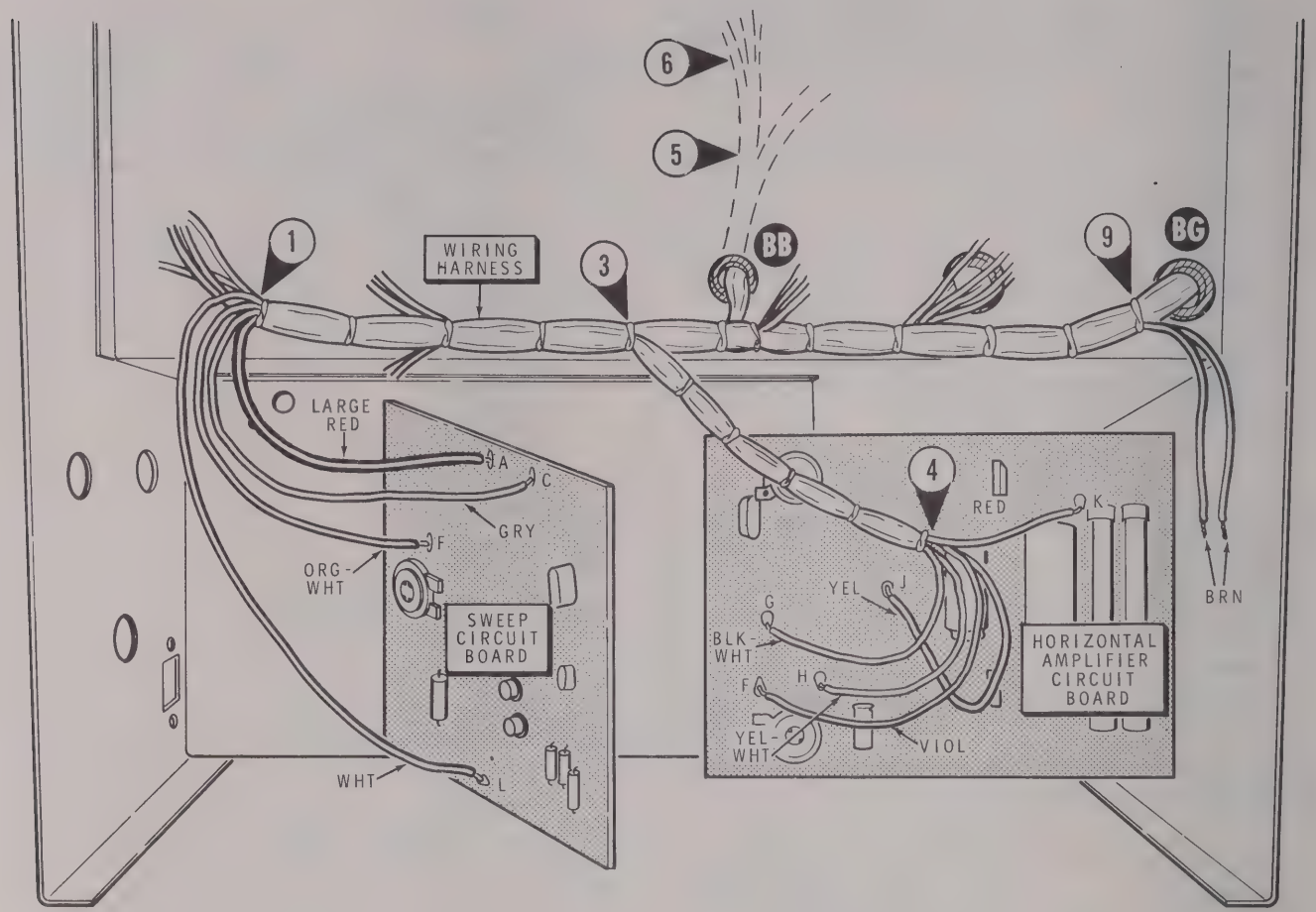
( ) Black wire (coming from hole AF) to lug 3 (S-1).

( ) Red wire (coming from hole AE) to lug 2 (S-1).

( ) White wire (coming from hole AD) to lug 1 (S-1).

Refer to Detail 5-7B (fold-out from Page 42) and position the wire harness as shown.





Detail 5-7C

( ) Refer to Detail 5-7C and insert the wires of BO#10 (breakout #10) through grommet BG as shown.

( ) Insert the wires of BO#5 and BO#6 through grommet BB as shown.

Connect the wires from BO#1 to the sweep circuit board as follows:

( ) Large red wire to hole A (S-1).

( ) Gray wire to hole C (S-1).

( ) Orange-white wire to hole F (S-1).

( ) White wire to hole L (S-1).

Connect the wires from BO#4 to the horizontal amplifier circuit board as follows:

( ) Violet to hole F (S-1).

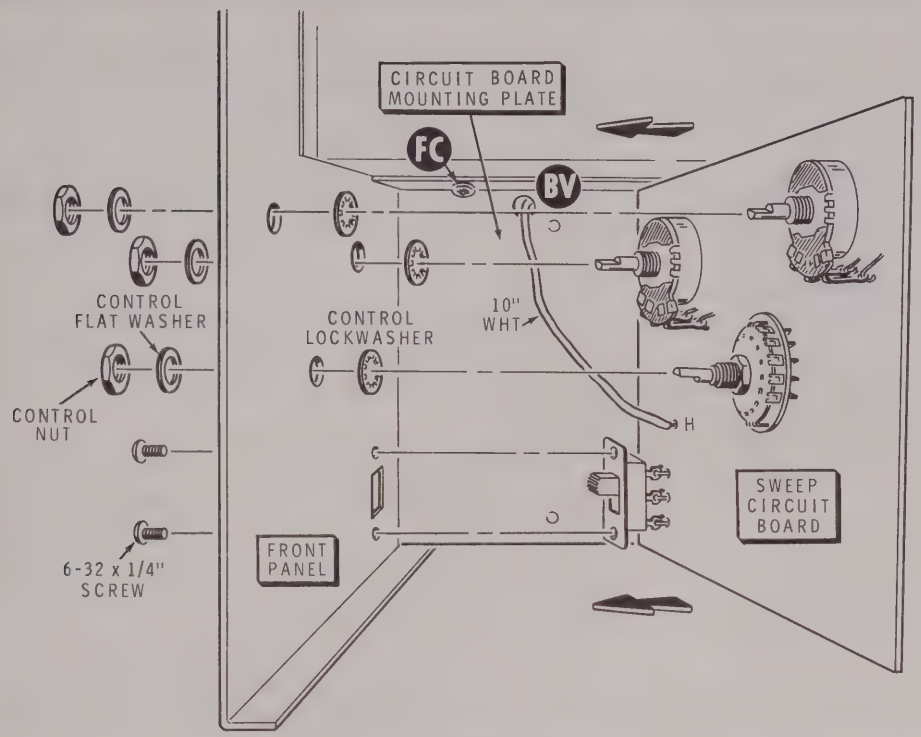
( ) Black-white wire to hole G (S-1).

( ) Yellow-white wire to hole H (S-1).

( ) Yellow wire to hole J (S-1).

( ) Red wire to hole K (S-1).

( ) Connect the free end of the red wire coming from hole A on the horizontal amplifier circuit board to hole G (on the foil side) of the sweep circuit board (S-1). See Pictorial 5-7 (fold-out from Page 49).



Detail 5-7D

Refer to Detail 5-7D for the following steps.

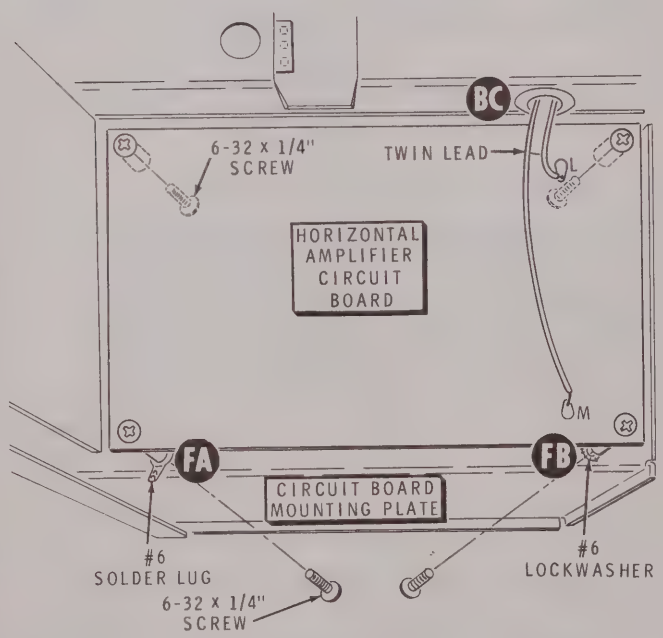
( ) Insert the free end of the 10" white wire coming from hole H of the sweep circuit board through hole BV in the circuit board mounting plate.

( ) Mount the sweep circuit board controls and switches to the front panel as shown. Use three control lockwashers, three control flat washers, three control nuts, and two 6-32 x 1/4" screws. NOTE: When positioning the sweep circuit board in place, be sure the circuit board has gone past screw head FC and that the circuit board is not bent.

Refer to Detail 5-7E for the following steps.

( ) Mount the horizontal amplifier circuit board to the circuit board mounting plate. Use four 6-32 x 1/4" screws, a #6 solder lug at FA, and a #6 lockwasher at FB. Be sure the solder lug at FA is positioned as shown in the Detail.

( ) Route the twin lead from holes M and L of the horizontal amplifier circuit board through grommet BC.



Detail 5-7E

Refer to Pictorial 5-7 (fold-out from Page 49) for the following steps.

( ) Connect the white wire coming from hole B of the horizontal amplifier circuit board to solder lug BA (S-2).

( ) Connect the white wire coming from hole B of the sweep circuit board to solder lug BS (NS).

( ) Connect the white wire coming from hole J of the sweep circuit board to solder lug FA (S-1).

Connect the wires from the front panel banana jacks to the sweep circuit board as follows. NOTE: Lay each wire end against the indicated foil of the circuit board. Do not use the circuit board holes for the next four steps.

( ) Connect the wire coming from red banana jack AH to foil M (S-1).

( ) Connect the wire coming from red banana jack AG to foil K (S-1).

( ) Connect the wire coming from black banana jack AF to foil N (S-1).

( ) Connect the wire coming from red banana jack AE to foil P (S-1).

Connect the remaining wires from BO#1 of the wiring harness to the front panel controls as follows:

( ) Brown-white wire to lug 2 of control AV (S-1). See the inset drawing.

( ) Black wire to lug 6 of control AV (S-1).

( ) Black-white wire to lug 3 of control AC (S-1).

( ) Yellow-white wire to lug 2 of control AC (S-1).

( ) Either brown wire to lug 4 of control AW (S-1).

( ) The remaining brown wire to lug 5 of control AW (S-1).

( ) Blue-white wire to lug 2 of control AB (S-1).

( ) Red-white wire to lug 1 of terminal collar AA (S-2).

( ) Position all wires near the chassis and check to be sure the leads of the capacitors on the foil side of the sweep circuit board are not touching other component leads or foils.

Refer to Pictorial 5-8 for the following steps.

( ) Route BO#5 and BO#6 of the wiring harness through small grommet BD.

Connect the wires from BO#6 to the vertical amplifier circuit board as follows:

( ) Brown-white wire to hole G (S-1).

( ) Blue wire to hole E (S-1).

( ) Black wire to hole F (S-1).

( ) Orange wire to hole H (S-1).

( ) Connect the red-white wire coming from BO#5 to hole J (S-1).

( ) Connect the white wire coming from circuit board mounting plate hole BV to hole M (S-1).

Connect the wires coming from the vertical amplifier circuit board as follows:

( ) Route the twin lead coming from hole K and hole L through grommet BE.

( ) Connect the white wire coming from hole B to the black banana jack lug AJ (S-2).

( ) Connect the red wire coming from hole A to lug 7 of switch AM (S-1).

( ) Connect the coaxial cable coming from hole D to control AC: Inner lead to lug 2 (S-1), shield lead to lug 3 (NS).

( ) Connect the coaxial cable coming from hole C to control AC: Inner lead to lug 1 (S-1), shield lead to lug 3 (S-3).

( ) Mount the vertical amplifier assembly to the circuit board mounting plate with four 6-32 x 1/4" screws. Also, use #6 lockwashers at DC and DD.

Refer to Pictorial 5-9 and Detail 5-9A for the following steps.

( ) Route the two wire groups of the power transformer through grommets BL and BM in the transformer top shield as shown. Continue to route the two wire groups through the two large holes in the chassis. NOTE: Be sure to route the proper colored wires through the proper holes as shown.

( ) Mount the transformer and transformer top shield to the chassis with 10-32 x 3/8" hardware as shown. Be sure no wires are pinched between the chassis and the top shield.

( ) Position the edges of the transformer side shield inside the transformer top shield. Secure the shields together with four 10-32 x 3/8" screws. NOTE: Be sure the four tapped holes in the bottom of the side shield are positioned as shown.

Refer to Pictorial 5-9 for the following steps.

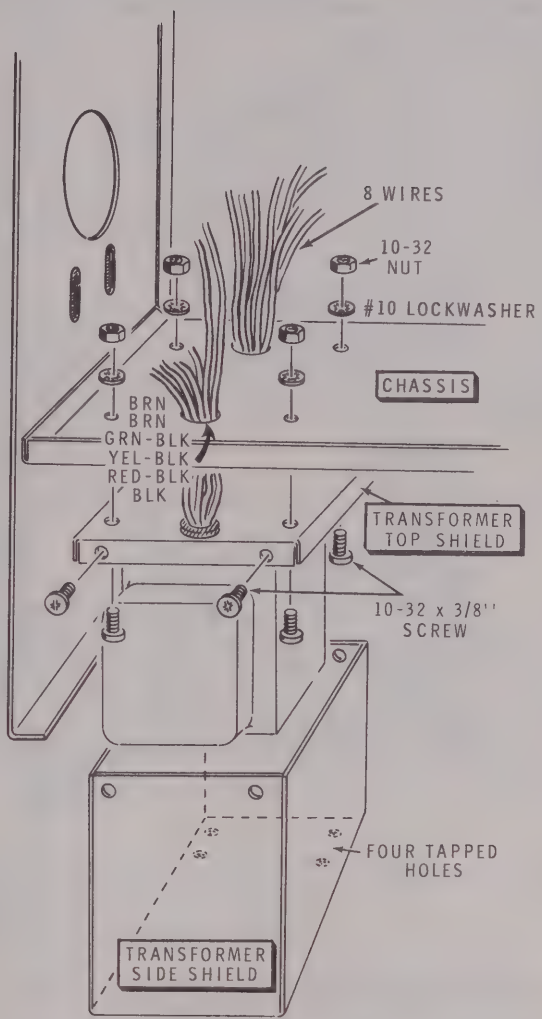
( ) Cut the two brown wires coming from grommet BM each to 10" and remove 1/4" of insulation from the two wire ends. Route these wires through the CRT hole.

( ) Route the remaining wires coming from grommet BM down through grommet BH.

( ) Route the eight wires coming from grommet BL through grommet BF.

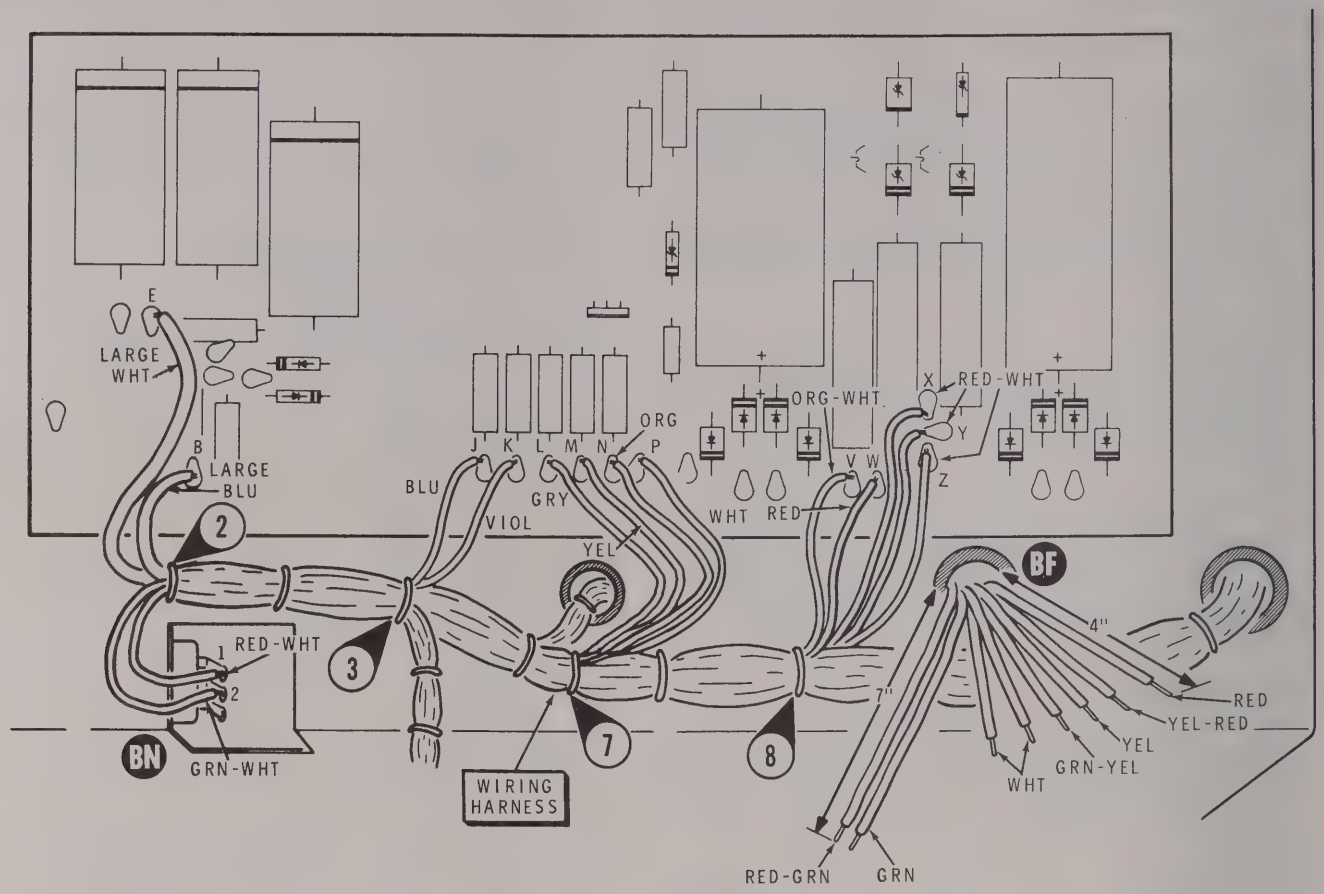
( ) Route BO#10 of the wiring harness through the CRT hole in the rear panel.

( ) Route the twin lead coming from grommet BE through grommet BK. NOTE: Be sure that the wire of the twin lead that is connected to hole K on the vertical amplifier circuit board is positioned toward the bottom of grommet BK as shown.



Detail 5-9A

( ) Route the twin lead coming from grommet BC under the wiring harness and through grommet BJ. NOTE: Be sure that the wire of the twin lead that is connected to hole L on the horizontal amplifier circuit board is positioned toward the bottom of grommet BJ as shown.



PICTORIAL 5-10

Refer to Pictorial 5-10 for the following steps.

Cut the wires coming from grommet BF to the following lengths: Measure the wires from the grommet. Then remove 1/4" of insulation from the wire ends.

( ) Red-green wire to 7".

( ) Green wire to 7".

Cut the remaining six wires to 4" as follows:

( ) Either white wire to 4".

( ) Other white wire to 4".

( ) Green-yellow wire to 4".

( ) Yellow wire to 4".

( ) Yellow-red wire to 4".

( ) Red wire to 4".

Connect wires from BO#2 of the wiring harness as follows:

( ) Red-white wire to lug 1 of control BN (S-1).

( ) Green-white wire to lug 2 of control BN (S-2).

( ) Large blue wire to hole B on the power supply circuit board (S-1).

( ) Large white wire to hole E on the power supply circuit board (S-1).

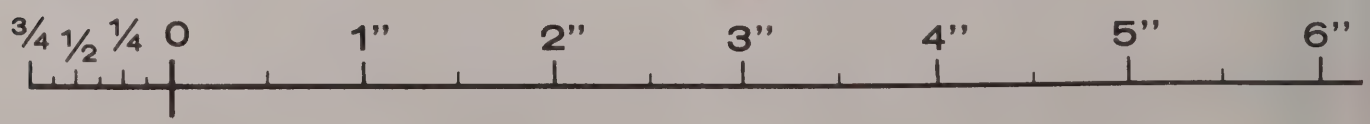
Connect the wires from BO#3 to the power supply circuit board as follows:

( ) Blue wire to hole J (S-1).

( ) Violet wire to hole K (S-1).

Connect the wires from BO#7 to the power supply circuit board as follows:

( ) Gray wire to hole L (S-1).



( ) Yellow wire to hole M (S-1).

( ) Orange wire to hole N (S-1).

( ) White wire to hole P (S-1).

Connect the wires from BO#8 to the power supply circuit board as follows:

( ) Orange-white wire to hole V (S-1).

( ) Red wire to hole W (S-1).

( ) Any of the three red-white wires to hole Z (S-1).

( ) A red-white wire to hole Y (S-1).

( ) The remaining red-white wire to hole X (S-1).

Refer to Pictorial 5-11 (fold-out from Page 50) and connect the wires coming from grommet BF to the power supply circuit board as follows:

( ) Red-green wire to hole G (S-1).

( ) Green wire to hole H (S-1).

( ) Either white wire to hole R (S-1).

( ) Remaining white wire to hole S (S-1).

( ) Yellow wire to hole T (S-1).

( ) Green-yellow wire to hole U (S-1).

( ) Red wire to hole AA (S-1).

( ) Yellow-red wire to hole AB (S-1).

( ) Mount the power supply circuit board on the 1/2" spacers previously mounted on the chassis. Use six 6-32 x 1/4" screws. Also use three #6 lockwashers at BP, BQ, and BR. See the inset drawing.

Connect the free ends of the wires coming from the power supply circuit board as follows:

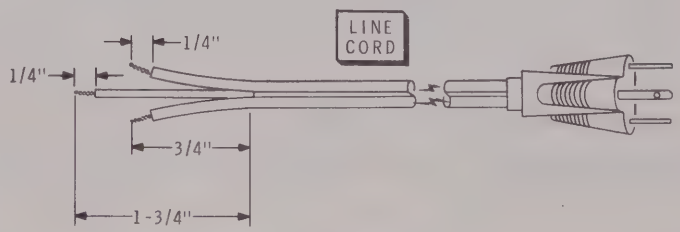
( ) White wire coming from hole A to solder lug BS (S-2).

( ) Black wire coming from hole C to lug 2 of control AW (S-1).

( ) White wire coming from hole D to lug 1 of control AW (S-1).

( ) Red wire coming from hole F to lug 1 of control AB (S-1).

NOTE: The line cord supplied with this kit has one of its outer wires marked with a rib in the insulation along its edge. The other wire is smooth, and the third wire is color coded green. It is very important that you connect the ribbed wire as indicated.



Detail 5-11A

( ) Refer to Detail 5-11A and prepare the end of the line cord as shown.

( ) Twist the bare wire strands together and melt a small amount of solder on the strands to hold them together.

( ) Pass the line cord through hole CE in the rear panel.

Connect the line cord as follows:

( ) Green wire to lug 3 of terminal strip CC (S-1).

( ) Ribbed wire to lug 5 of terminal strip CC (NS).

( ) Smooth wire to lug 2 of fuseholder CD (S-1).

Connect the wires coming from grommet BH to terminal strip CC as follows:

( ) Black wire to lug 5 (NS).

( ) Green-black wire to lug 4 (NS).

( ) Yellow-black wire to lug 2 (NS).

( ) Red-black wire to lug 1 (NS).

( ) Cut a 3" length of wire off each of the two brown wires from BO#9 and set these aside. Then remove 1/4" of insulation from the two wires from BO#9 and apply solder to the bare ends to hold the wire strands together.

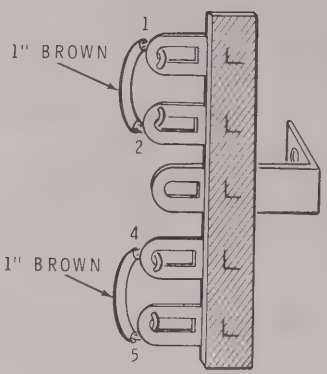
( ) Connect either brown wire to lug 1 of terminal strip CC (NS).

( ) Connect the other brown wire to lug 1 of fuseholder CD (S-1).

ALTERNATE LINE VOLTAGE WIRING

Two sets of line voltage wiring instructions are given below, one for 120 Vac line voltage and the other for 240 Vac line voltage. In the United States, 120 Vac is most often used, while in foreign countries 240 Vac is more common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.

120 Vac Wiring



Detail 5-11B

Refer to Detail 5-11B for the following steps.

Prepare the two lengths of brown wire previously cut off the wiring harness as follows:

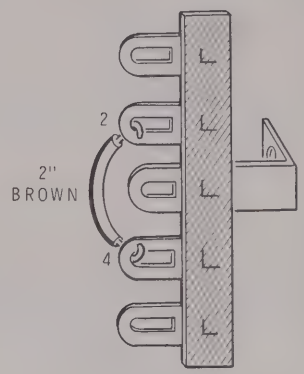
1" brown wire
1" brown wire

( ) Twist the bare wire strands together and melt a small amount of solder on the four ends to hold the strands together.

( ) Connect a 1" length of brown wire between lug 1 (S-3) and lug 2 (S-2) of terminal strip CC.

( ) Connect a 1" length of brown wire between lug 4 (S-2) and lug 5 (S-3) of terminal strip CC.

240 Vac Wiring



Detail 5-11C

Refer to Detail 5-11C for the following steps.

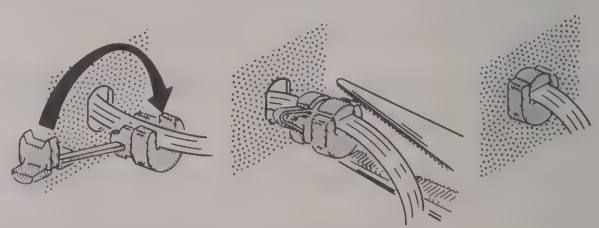
( ) Prepare a 2" length of brown wire from one of the brown wires previously cut off the wiring harness.

( ) Connect the wire between lug 2 (S-2) and lug 4 (S-2) of terminal strip CC.

( ) Solder the unsoldered connection at lug 1 of the terminal strip (S-2).

( ) Solder the unsoldered connection at lug 5 of the terminal strip (S-2).

( ) Refer to Detail 5-11D and install a line cord strain relief on the line cord at CE.



Detail 5-11D

TUBE SOCKET WIRING

Refer to Pictorial 5-12 for the following steps.

( ) Refer to Detail 5-12A and route the two brown wires coming from the CRT hole above the CRT clamp and BO#10 of the wiring harness under the CRT clamp as shown.

Refer to Pictorial 5-12 and connect the wires coming through the rear panel to the tube socket as follows:

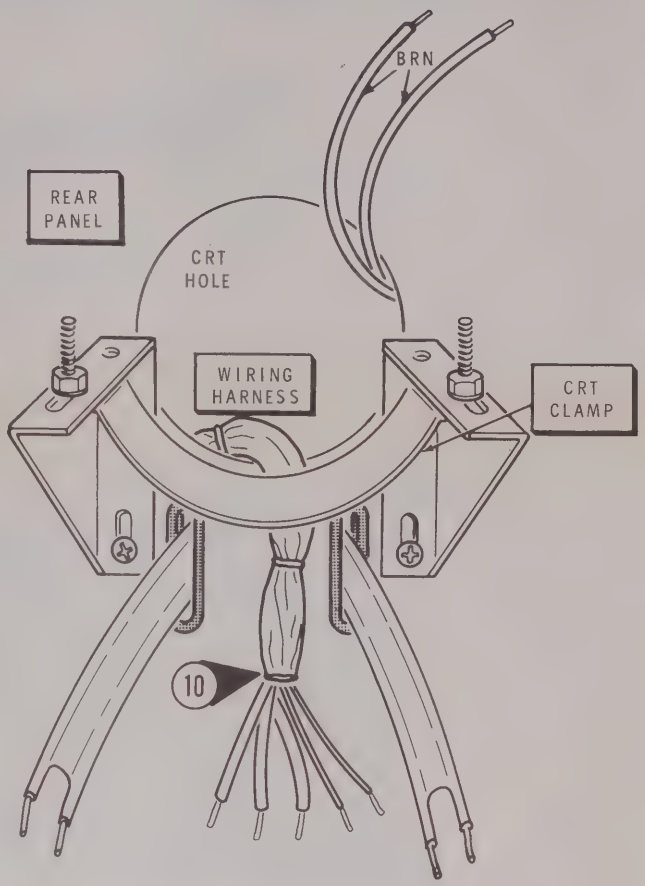
( ) Position the tube socket as shown. Be sure the "keyway" is pointed up.

( ) Connect the twin lead coming from grommet BJ. Connect the upper wire to lug 10 (S-1) and the lower wire to lug 9 (S-1).

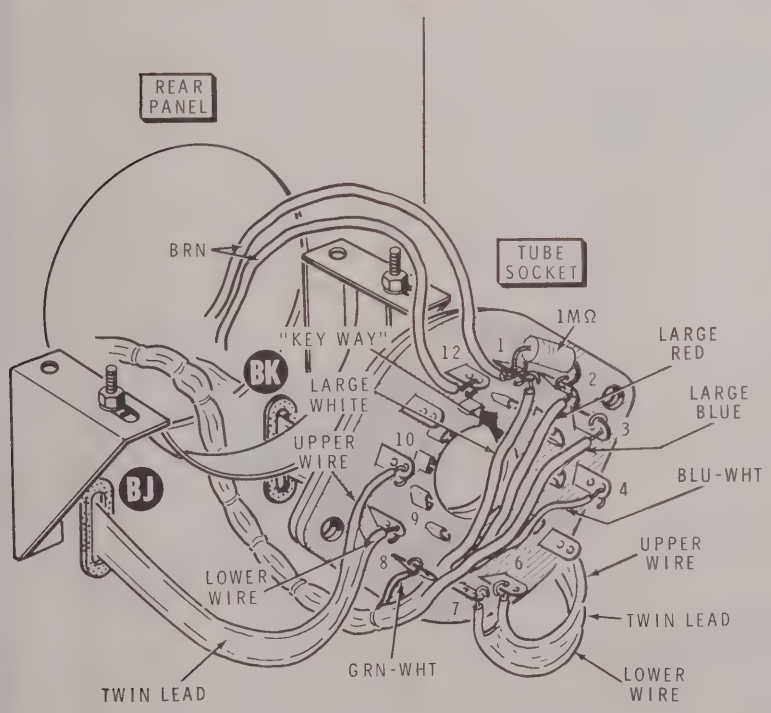
( ) Connect the twin lead coming from grommet BK. Connect the upper wire to lug 6 (S-1) and the lower wire to lug 7 (S-1).

NOTE: In the following step, use the lug holes nearest the tube socket and be sure no solder flows into the other hole of either lug.

( ) Connect a 1 MΩ (brown-black-green) resistor between lugs 1 (S-1) and 2 (S-1).



Detail 5-12A



PICTORIAL 5-12

( ) Connect one brown wire to lug 12 (S-1).

( ) Connect the other brown wire to lug 1 (NS).

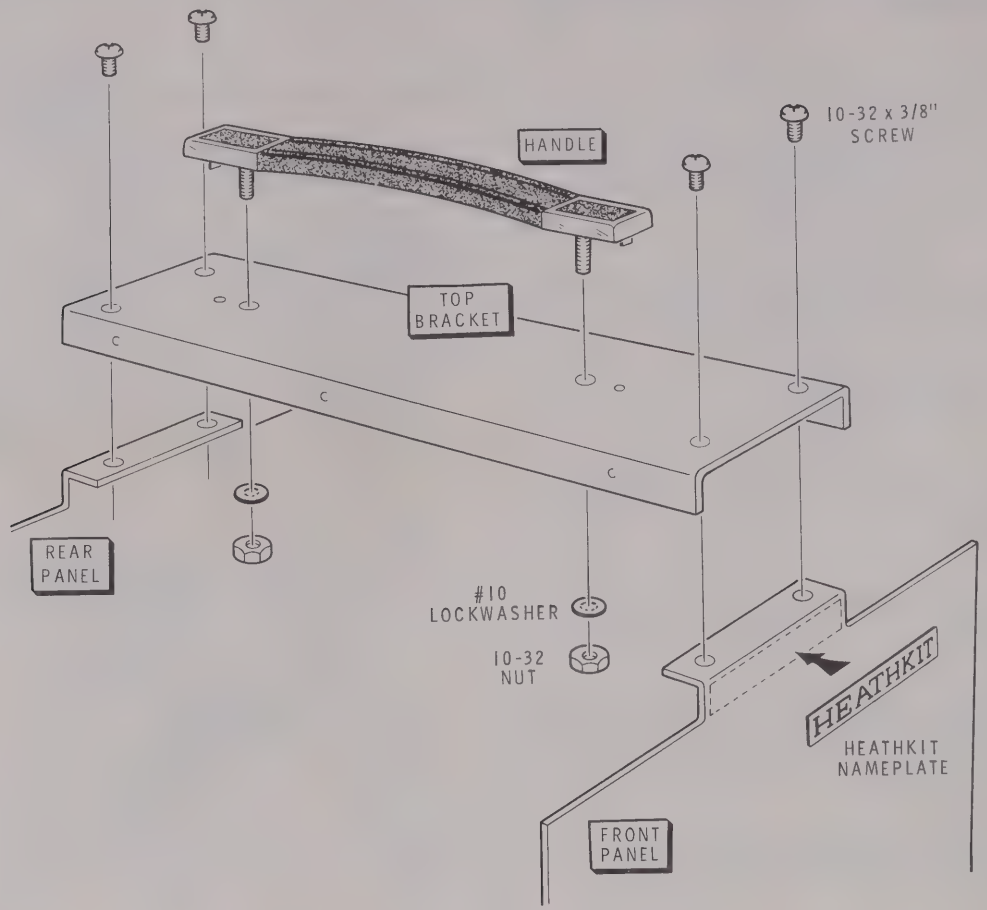
( ) Connect the green-white wire to lug 8 (S-1).

( ) Connect the large white wire to lug 1 (S-2).

( ) Connect the large red wire to lug 2 (S-1).

( ) Connect the large blue wire to lug 3 (S-1).

( ) Connect the blue-white wire to lug 4 (S-1).



PICTORIAL 5-13

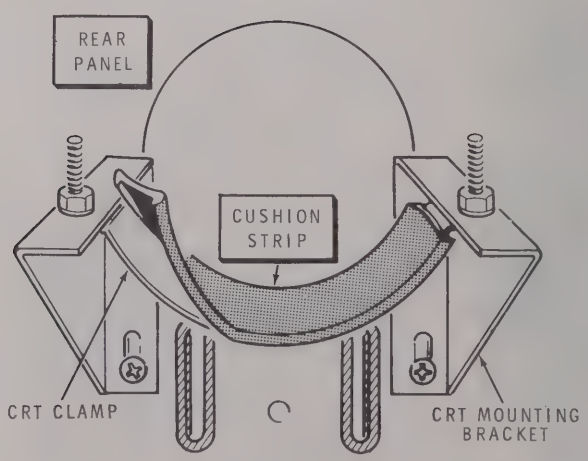
HANDLE MOUNTING

Refer to Pictorial 5-13 for the following steps.

( ) Mount the handle to the top bracket as shown. Use two #10 lockwashers and two 10-32 nuts.

( ) Mount the top bracket to the front and rear panels. Use four 10-32 x 3/8" screws and be sure that the handle is positioned towards the rear of the Oscilloscope as shown.

( ) Remove the protective backing from the "Heathkit" nameplate and install it at the top of the front panel as shown.



Detail 5-14A

CRT INSTALLATION

Refer to Pictorial 5-14 (fold-out from Page 59) and Detail 5-14A for the following steps.

( ) Cut two 2-1/4" lengths of cushion strip.

( ) Place one length of cushion strip on the CRT clamp already installed on the CRT mounting brackets on the rear panel.

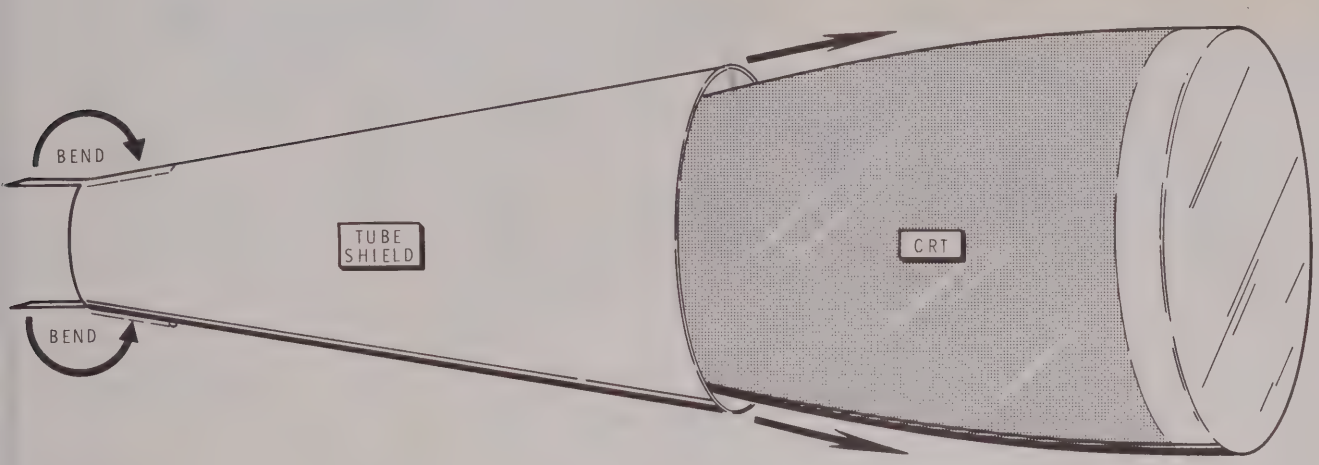
WARNING: Handle the CRT very carefully. Because of its high vacuum, do not strike, scratch, or subject the CRT to more than moderate pressure at any time. A fracture of the glass could result in an implosion of considerable violence capable of causing personal injury.

( ) Carefully unpack the CRT.

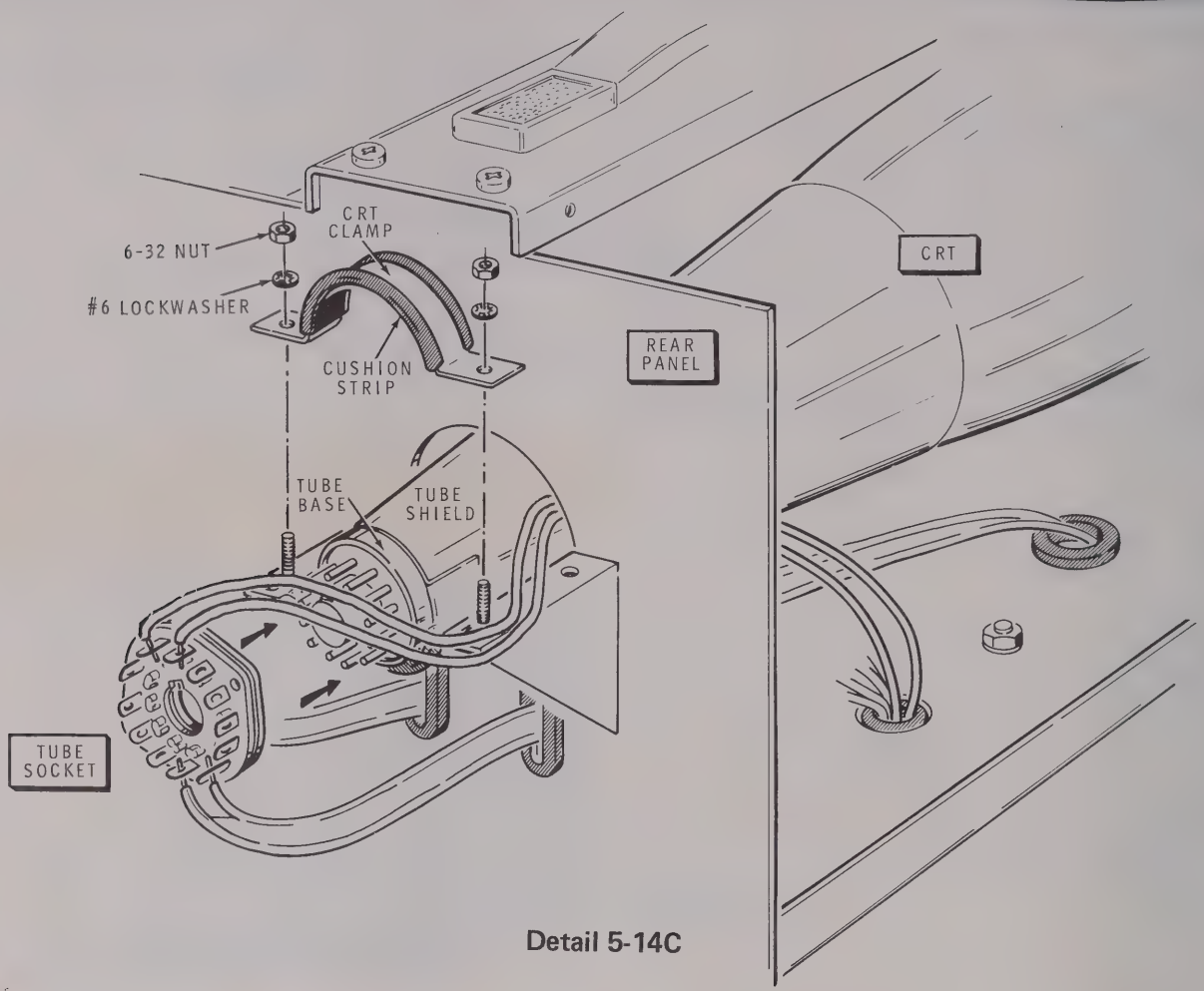
Refer to Detail 5-14B for the following steps.

( ) Place the tube shield on the CRT. Carefully push it on as far as it will go.

( ) Bend the two tabs of the tube shield as shown.



Detail 5-14B



Detail 5-14C

( ) Refer to Pictorial 5-14 and insert the CRT through the front panel CRT hole until the face of the CRT is flush with the front panel and the neck of the CRT rests on the cushion on the CRT clamp. See Detail 5-14C.

( ) Refer to Detail 5-14C and place the remaining length of cushion strip on the remaining CRT clamp. Mount the clamp to the CRT mounting brackets, finger tight, with the 6-32 hardware that was loosely installed earlier.

NOTE: Be sure the "key" of the CRT is pointing toward the 11 o'clock position as shown.

( ) Carefully push the tube socket onto the CRT.

NOTE: There may be a protective covering on the graticule or window to protect this part (or these parts) from being scratched. Remove the coverings before the parts are installed in the following step. If a covering is not removed, the beam in the CRT will not appear to be focused after the kit is assembled.

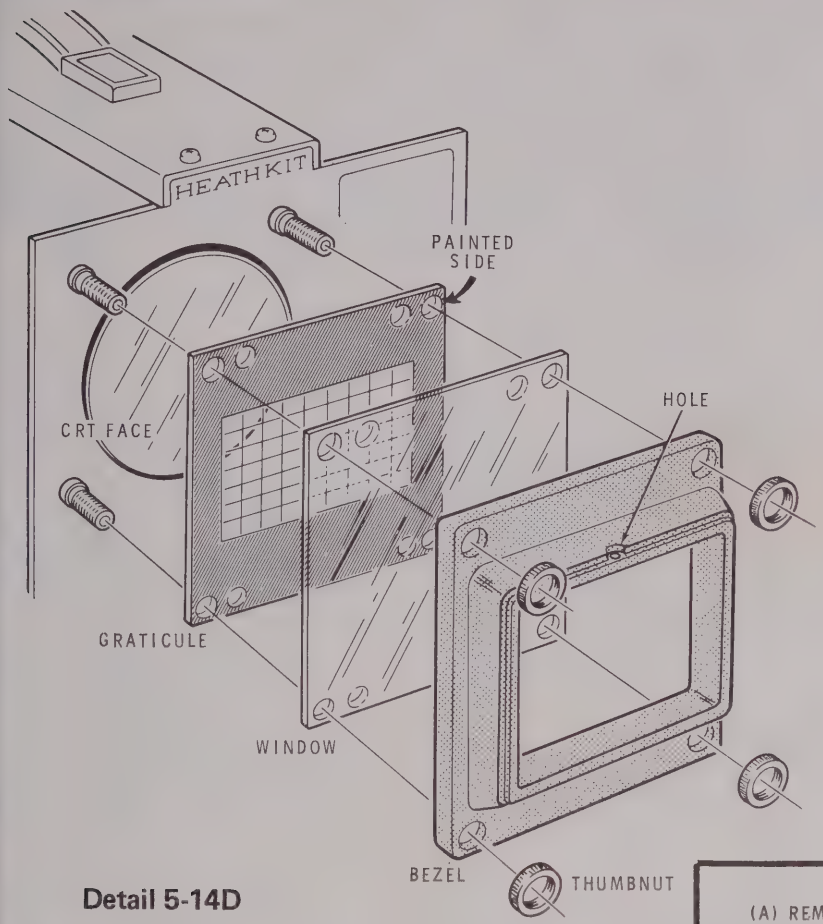
( ) Refer to Detail 5-14D and install the graticule, window, and bezel over the face of the CRT. Use four thumbnuts. NOTE: Be sure that the painted side of the graticule is away from the CRT face and that the hole in the bezel is positioned up as shown.

( ) Push the CRT forward until the CRT face is against the graticule. Then tighten the 6-32 hardware holding the CRT clamps. NOTE: The cushion strips must fit over as much of the tube base as possible and not just over the tube shield.

KNOB INSTALLATION

Refer to Pictorial 5-15 for the following steps.

( ) Turn all the control and switch shafts on the front panel to their full counterclockwise position.



Detail 5-14D

( ) Push a knob insert onto the VERTICAL switch shaft. Then press a large knob part way onto the insert. (Be sure the pointer is pointing as shown in the Pictorial.)

( ) Remove both the knob and knob insert as one unit. Refer to the inset drawing on the Pictorial and press the insert all the way into the knob cavity with a nut driver or other suitable instrument. Replace the knob on the VERTICAL switch shaft.

In the same manner, install knobs at the following locations:

( ) The remaining large knob on the HORIZONTAL sweep switch shaft.

( ) A small knob with pointer on the vertical GAIN control shaft.

( ) A small knob with pointer on the horizontal GAIN control shaft.

( ) A small knob with pointer on the INTENSITY control shaft.

( ) A small knob on the FOCUS control shaft.

( ) A small knob on the VERT position control shaft.

( ) A small knob on the HORIZ position control shaft.

( ) A small knob on the FREQ VERN control shaft.

WARNING: Do not turn the Oscilloscope on until instructed to do so, or the components will be damaged.

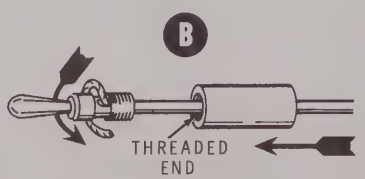
TEST LEADS

( ) Prepare the red test lead as shown in part A of Detail 5-15A. Then install a banana plug with a red insulator on one end and an alligator clip on the other end of the test lead as shown in parts B and C of the Detail.

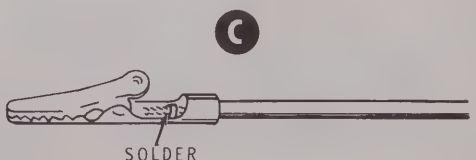
( ) In a similar manner, prepare the black test lead with a black insulator.

(A) REMOVE THE INSULATION FROM EACH END OF THE RED TEST LEAD AND TWIST TOGETHER THE FINE WIRES.

(B) INSERT THE 3/4" END OF THE TEST LEAD THROUGH THE INSULATOR AND INTO THE BANANA PLUG. THEN WRAP THE END OF THE LEAD COUNTER-CLOCKWISE AROUND THE PLUG AND SCREW THE INSULATOR ON.



(C) INSERT THE OTHER END OF THE TEST LEAD INTO THE ALLIGATOR CLIP. SOLDER THE LEAD.



Detail 5-15A

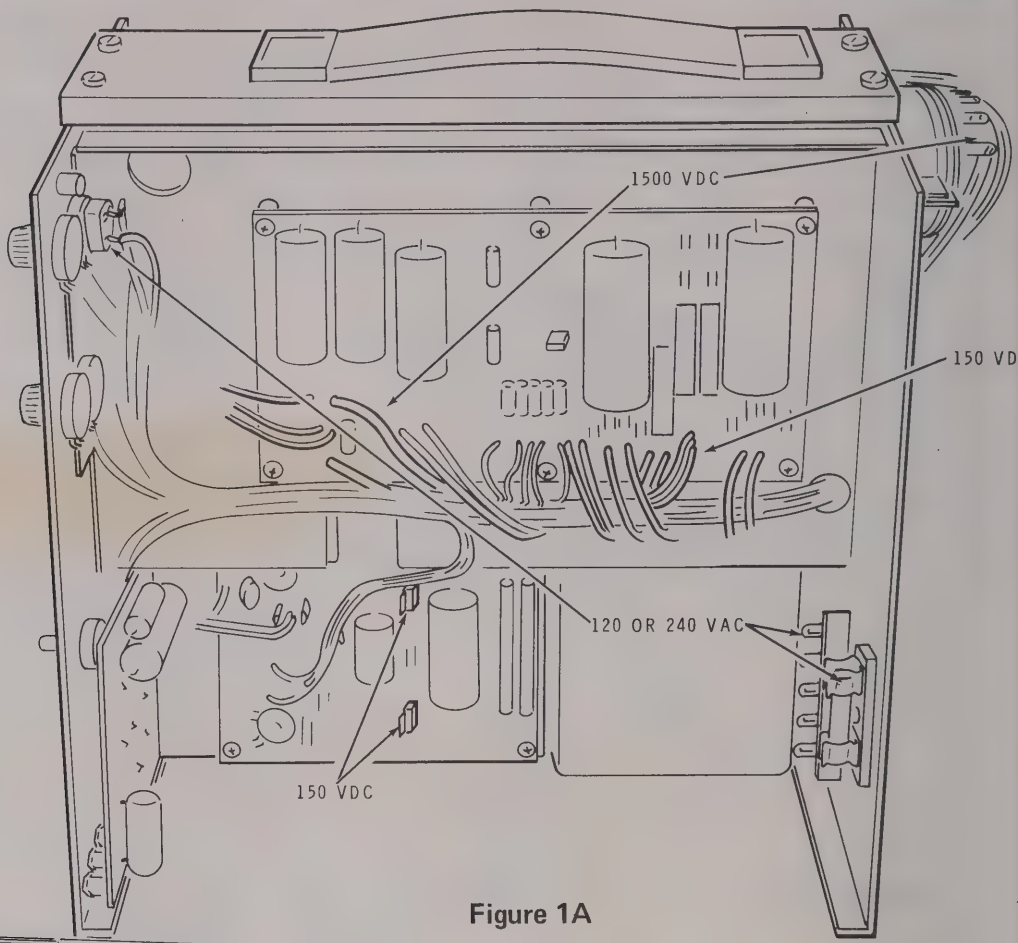


Figure 1A

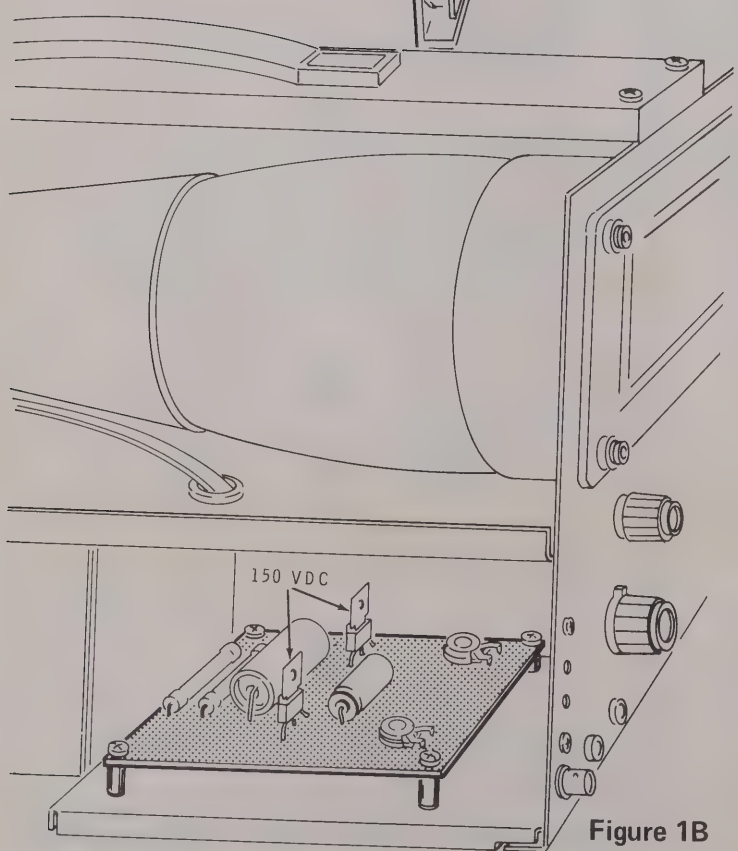


Figure 1B

TESTS AND ADJUSTMENTS

In this section of the Manual, you will test the operation of your Oscilloscope and make necessary adjustments before you complete the "Final Assembly." If any trouble is encountered or the test results cannot be obtained in the following tests or adjustments, turn the power off and refer to the "In Case of Difficulty" section on Page 75.

An 11 megohm input voltmeter is required to make the following tests and adjustments.

Figure 1 (fold-out from Page 60) shows the front panel of the Oscilloscope. Study the figure carefully to identify the function of each switch, control, jack, and connector.

AMPLIFIER BALANCE

( ) Set the front panel controls and switches as follows:

INTENSITY: Fully clockwise and pushed in.

FOCUS: Center of rotation.

VERT Position (Fine): Center of rotation.

NOTE: To make the following VERT Position (Coarse) control setting, remove the knob from the VERT Position control, insert a small screwdriver into the hollow shaft, and make the setting.

VERT Position (Coarse): Center of rotation.

HORIZ Position: Center of rotation.

Vertical GAIN: Fully counterclockwise.

VERTICAL Attenuator Switch: GND.

SYNC: INT.

Horizontal GAIN: Fully counterclockwise.

HORIZONTAL Frequency Switch: EXT IN.

FREQ VERN: Center of rotation.

( ) Refer to Figures 2 through 5 (on the following pages) and set the internal controls as follows:

ASTIGMATISM: Fully counterclockwise.

HORIZ DC BALANCE: Center of rotation.

HORIZ 100 V ADJUST: Center of rotation.

SYNC LEVEL: Fully counterclockwise.

VERT DC BALANCE: Center of rotation.

VERT 100 V ADJUST: Center of rotation.

( ) Set the VTVM to measure + 250 volts dc.

( ) Connect the VTVM negative test lead to chassis ground.

( ) Connect the Oscilloscope line cord plug to an ac outlet.

WARNING: High voltage is present at several locations in the Oscilloscope. See Figure 1A and Figure 1B.

( ) Pull the INTENSITY control to the "on" position. The Power lamp should come on. Allow the Oscilloscope to warm up for approximately 30 seconds.

Refer to Figure 2 (fold-out from Page 65) for the following steps.

( ) Alternately measure the voltage at the collectors of Q207 and Q208. Adjust the HORIZ position control until these voltages are equal. NOTE: As the HORIZ position control is rotated in one direction, the voltage at one collector will increase while the voltage at the other collector decreases.

( ) Adjust the HORIZ 100 V ADJUST control for a 100-volt meter indication at the collector of Q208.

( ) Repeat the two previous steps until the collector voltage at both Q207 and Q208 is 100 volts.

Refer to Figure 3 for the following steps.

( ) Position the Oscilloscope on its side as shown in Part A of the Figure.

( ) Alternately measure the voltage at the collectors of Q9 and Q10. With a small screwdriver, adjust the VERT position (Coarse) control until the voltages are equal. NOTE: As the VERT position (Coarse) control is rotated in one direction, the voltage at one collector will increase while the voltage at the other collector decreases.

( ) Adjust the VERT 100 V ADJUST control for a 100-volt meter indication at the collector of Q9.

( ) Repeat the two previous steps until the collector voltage at both Q9 and Q10 is 100 volts. A spot should be on the CRT.

( ) Replace the VERT Position control knob.

NOTE: Perform the following three steps once, and then perform them again before proceeding.

( ) 1. Set the VTVM to measure +1.5 volts dc and connect it to lug 1 of the vertical GAIN control. Then adjust the VERT DC BALANCE for an indication of zero volts.

( ) 2. Set the VTVM to measure +150 volts and then alternately measure the voltage at the collectors of Q9 and Q10. Adjust the VERT position (Fine) control until these voltages are equal.

( ) 3. Adjust the VERT 100 V ADJUST control for a 100-volt meter indication at the collector of Q9.

NOTE: Due to the high sensitivity of this scope, the following adjustment is sensitive. Therefore, it may be necessary to perform the following step again after the Oscilloscope has been completely assembled. A hole is provided in the cabinet for this purpose. Be sure the Oscilloscope has warmed up for half an hour before performing the step.

( ) Note the position of the spot on the CRT and rotate the vertical GAIN control from minimum to maximum. If the spot on the CRT moves vertically, adjust the VERT DC BALANCE control until the spot returns to its original position. Perform this step as often as necessary until the spot remains stationary as the vertical GAIN control is rotated.

( ) Rotate the horizontal GAIN control from minimum to maximum. The spot should not move horizontally. If it does, perform the following three steps. It may be necessary to repeat these steps to obtain proper operation.

NOTE: Perform the following three steps once, and then perform them again before proceeding.

( ) 1. Set the VTVM to measure +1.5 volts dc and connect it to the source (S) of transistor Q201. Then adjust the HORIZ DC BALANCE for an indication of zero volts.

( ) 2. Set the VTVM to measure +150 volts and then alternately measure the voltage at the collector of Q207 and Q208. Adjust the HORIZ position control until these voltages are equal.

( ) 3. Adjust the HORIZ 100 V ADJUST control for a 100-volt meter indication at the collector of Q208.

( ) Note the position of the spot on the CRT and rotate the horizontal GAIN control from minimum to maximum. If the spot moves horizontally, adjust the HORIZ DC BALANCE control until the spot returns to its original position. Perform this step as often as necessary until the spot remains stationary as the horizontal GAIN control is rotated.

TRACE ADJUSTMENT

Refer to Figure 2 for the following steps.

( ) Set the VTVM to measure +150 volts dc.

( ) Connect the VTVM test probe to the center lug of the ASTIGMATISM control.

( ) Adjust the ASTIGMATISM control for a 100-volt meter indication.

( ) Set the horizontal GAIN control to the center of rotation.

( ) Set the HORIZONTAL frequency switch to the 100 Hz – 1 kHz position.

( ) Adjust the INTENSITY and FOCUS controls for the sharpest trace.

Refer to Figure 3 for the following steps.

( ) Position the Oscilloscope on its side as shown in Part A of the Figure.

( ) Measure the voltage at the positive end of capacitor C5. Your meter should indicate 9V (±10%). Turn the VERT 100 V ADJUST control clockwise until the meter reading begins to drop. Return the control just enough (counterclockwise) for the meter to indicate 9 V again.

( ) Measure the voltage of the base of Q5. Adjust the VERT position (Coarse) control to obtain the same voltage at the base of Q6.

( ) Turn the VERT 100 V ADJUST control counterclockwise for a 100-volt meter indication at the collector of Q9.

( ) Alternately measure the voltage at the collectors of Q9 and Q10. With a small screwdriver, adjust the VERT position (Coarse) control slightly until the voltages are equal. NOTE: As the VERT position (Coarse) control is rotated in one direction, the voltage at one collector will increase while the voltage at the other collector decreases.

( ) Position the Oscilloscope on its side as shown in Part A of the Figure.

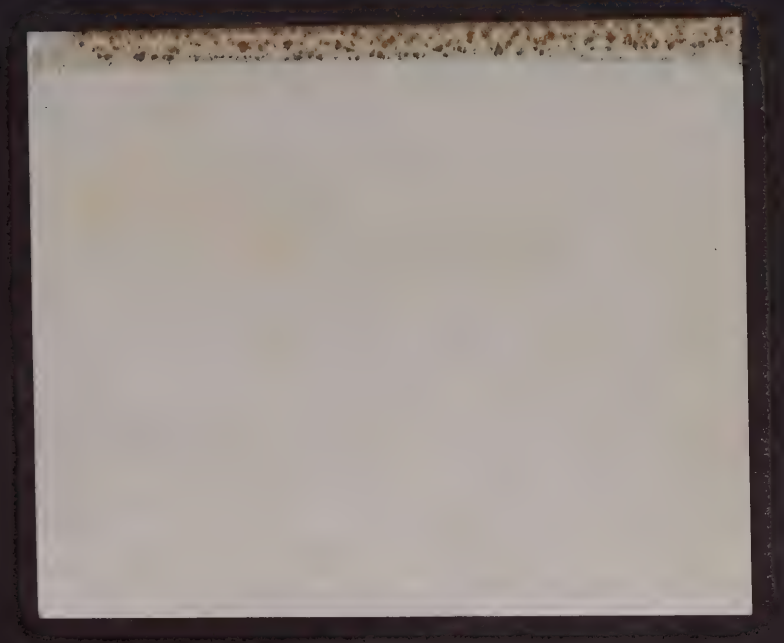
( ) Measure the voltage at the base of Q5. Adjust the VERT position (Coarse) control to obtain the same voltage at the base of Q6.

( ) Turn the VERT 100V ADJUST control clockwise for a 100-volt meter indication at the collector of Q9. It should not be necessary to go much beyond the center of rotation.

( ) Alternately measure the voltage at the collectors of Q9 and Q10. With a small screwdriver, adjust the VERT position (Coarse) control slightly until the voltages are equal. NOTE: As the VERT position (Coarse) control is rotated in one direction, the voltage at one collector will increase while the voltage at the other collector decreases.

( ) Repeat the two previous steps until the collector voltage at both Q9 and Q10 is 100 volts. A spot should be on the CRT.

( ) Replace the VERT Position control knob.



Check to make sure the horizontal line is parallel with the horizontal graticule lines. If these lines are parallel, proceed to the next check step. If they are not parallel, complete the following numbered steps.

1. Note the relative position of the horizontal line and unplug the line cord plug.
2. Loosen the CRT clamp nuts.
3. Rotate the CRT slightly.
4. Plug in the line cord and again check the position of the horizontal line.
5. Repeat steps 1 through 4 as necessary to align the horizontal line.
6. After the correct results have been obtained, unplug the line cord plug and tighten the CRT clamp nuts.

Turn the HORIZONTAL frequency switch to each of its positions. A horizontal line should appear at all but the EXT IN position. Leave this switch at the EXT IN position.

Connect a test lead from the 1 V P-P jack to the HORIZ IN jack.

Turn the horizontal GAIN control fully clockwise. A horizontal line approximately 10 cm long should appear. Disconnect the test lead from the HORIZ IN jacks.

Turn the horizontal GAIN control fully counterclockwise.

Connect the test lead from the 1 V P-P jack to the VERT IN jack.

Set the VERTICAL attenuator switch to the AC X 10 position.

Turn the vertical GAIN control fully clockwise. A vertical line approximately 4 cm high should appear. Disconnect the test lead from the 1 V P-P and VERT IN jacks.

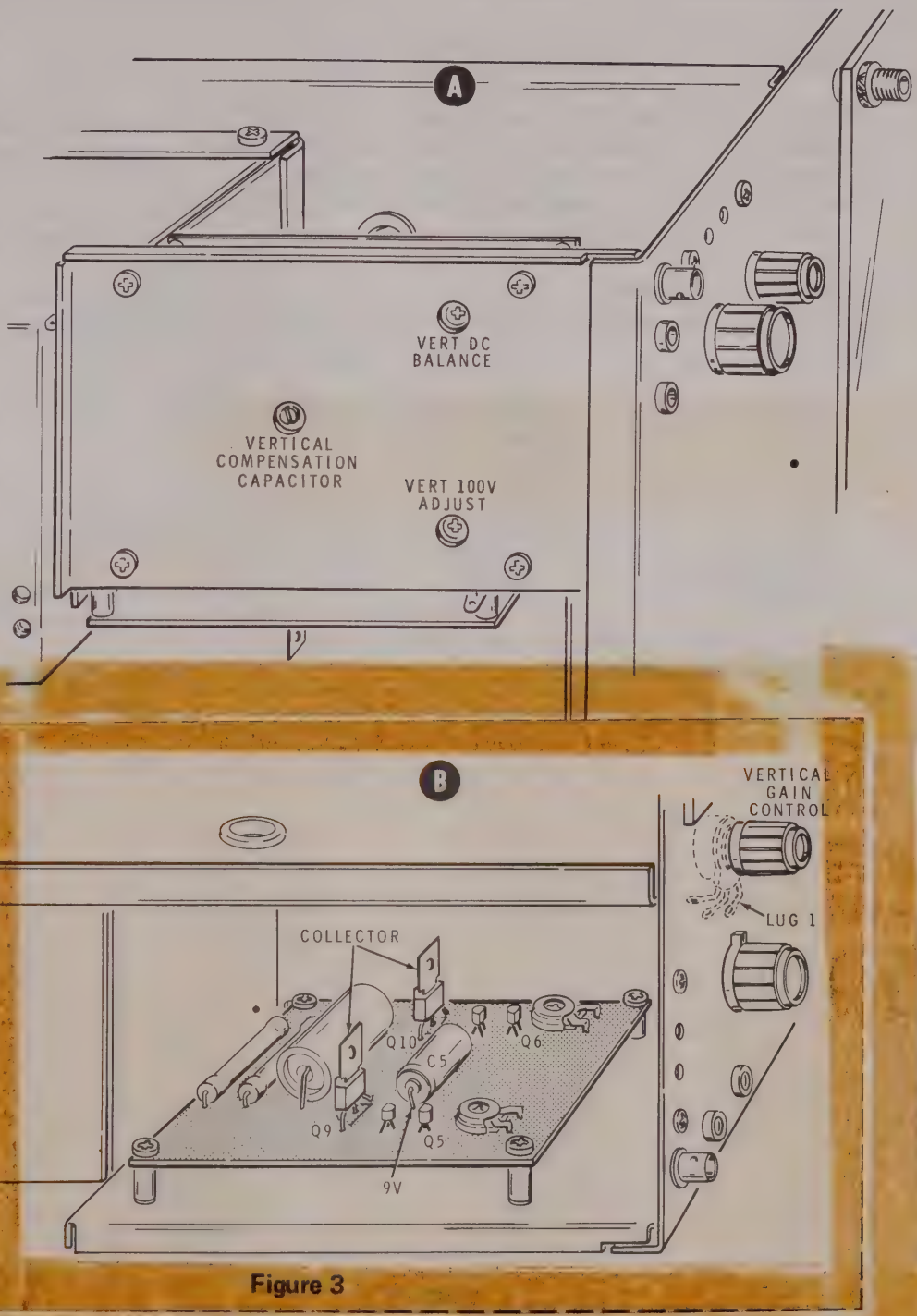


Figure 3

Turn the VERTICAL attenuator switch to the GND position.

Turn the VERT position control clockwise and counterclockwise. The spot should move up (clockwise) and down (counterclockwise).

Turn the HORIZ position control clockwise and counterclockwise. The spot should move to the right (clockwise) and to the left (counterclockwise).

SYNC LEVEL, VERTICAL ATTENUATOR, AND VERTICAL COMPENSATION ADJUSTMENTS

NOTE: Either of two methods can be used to make these adjustments. If a sine-square wave generator is available, complete the instructions under "With Signal Generator." If one is is not available, complete the instructions under "Without Signal Generator."

With Signal Generator

( ) Set the signal generator to produce a 1 kHz 1-volt sine wave.

( ) Connect the output of the generator to the VERT IN connector of the Oscilloscope.

( ) Set the VERTICAL attenuator switch to AC X10.

( ) Set the vertical GAIN control to the center of rotation.

( ) Set the HORIZONTAL frequency switch to the 100 Hz – 1 kHz position.

( ) Adjust the horizontal GAIN and the HORIZ POSITION controls until the display on the CRT extends from the left edge of the graticule to the right edge of the graticule.

( ) Turn the FREQ VERN control to display approximately 6 cycles.

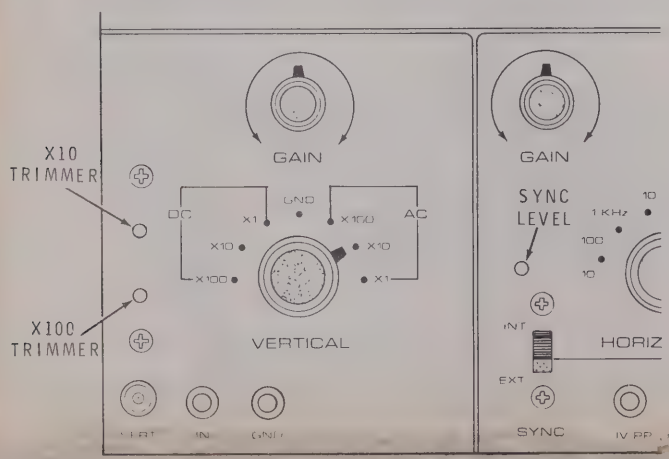


Figure 4

Refer to Figure 4 for the following steps.

( ) Slowly reduce the generator amplitude until the waveform loses sync. Then adjust the SYNC LEVEL control until the waveform "locks in." Repeat this procedure to obtain sync with the smallest possible waveform.

( ) Set the signal generator to produce a 100 kHz 1-volt sine wave.

( ) Set the HORIZONTAL frequency switch to 10 kHz – 100 kHz position.

( ) Adjust the FREQ VERN control to display approximately 6 cycles.

( ) Slowly reduce the generator amplitude. If the waveform loses sync, carefully readjust the SYNC LEVEL control until the waveform "locks in."

( ) Set the signal generator to produce a 1 kHz square wave.

( ) Adjust the generator amplitude to produce approximately 4 cm of vertical deflection.

( ) Set the HORIZONTAL frequency switch to the 100 – 1 kHz position.

( ) Turn the FREQ VERN control to display several cycles.

Figure 5 shows the waveforms for the correct amount of circuit compensation, too little compensation, and too much compensation respectively. When making the following adjustments, the waveform should look like Part A of Figure 5.

( ) Adjust the X10 trimmer capacitor until the waveform appears as shown in Part A of Figure 5.

( ) Turn the VERTICAL attenuator switch to AC X100.

( ) Adjust the X100 trimmer capacitor until the waveform appears as shown in Part A of Figure 5.

( ) Set the VERTICAL attenuator switch to AC X10.

( ) Set the HORIZONTAL frequency switch to the 10 kHz – 100 kHz position.

( ) Set the signal generator to produce a 100 kHz square wave.

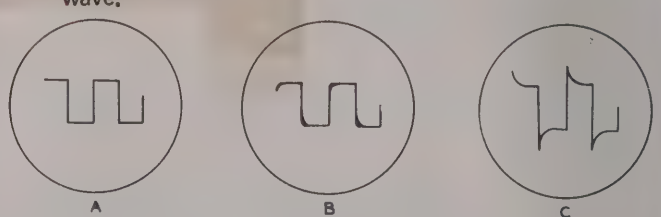
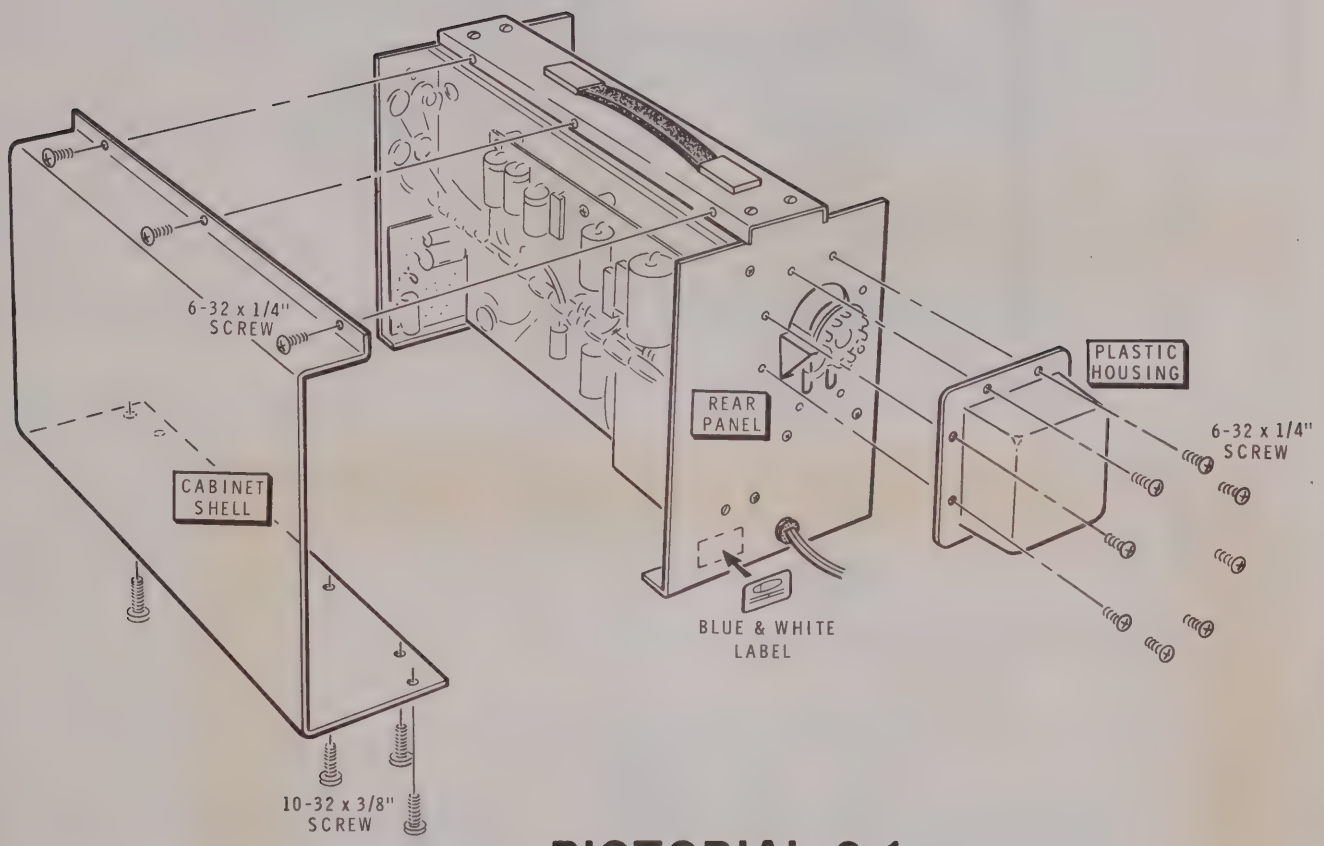


Figure 5

NOTE
DEPENDING ON THE RISE TIME OF YOUR SIGNAL GENERATOR YOU MAY OR MAY NOT SEE THE VERTICAL PORTION(S) OF YOUR SQUARE WAVE(S)



PICTORIAL 6-1

SYNC LEVEL, VERTICAL ATTENUATOR, AND VERTICAL COMPENSATION ADJUSTMENTS

NOTE: Either of two methods can be used to make these adjustments. If a sine-square wave generator is available, complete the instructions under "With Signal Generator." If one is is not available, complete the instructions under "Without Signal Generator."

With Signal Generator

( ) Set the signal generator to produce a 1 kHz 1-volt sine wave.

( ) Connect the output of the generator to the VERT IN connector of the Oscilloscope.

( ) Set the VERTICAL attenuator switch to AC X10.

( ) Set the vertical GAIN control to the center of rotation.

( ) Set the HORIZONTAL frequency switch to the 100 Hz – 1 kHz position.

( ) Adjust the horizontal GAIN and the HORIZ POSITION controls until the display on the CRT extends from the left edge of the graticule to the right edge of the graticule.

( ) Turn the FREQ VERN control to display approximately 6 cycles.

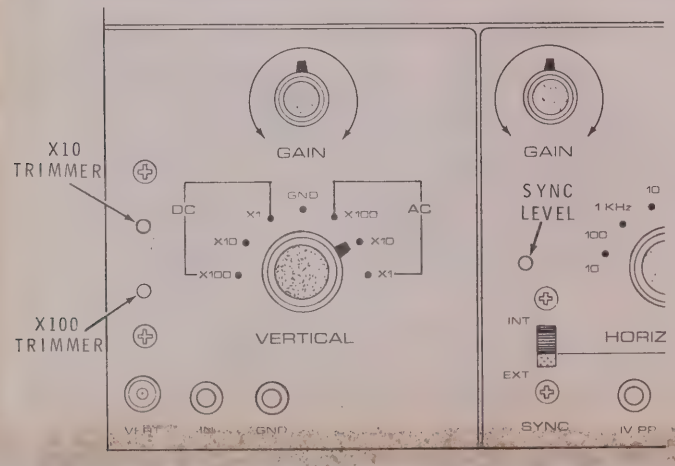


Figure 4

Refer to Figure 4 for the following steps.

( ) Slowly reduce the generator amplitude until the waveform loses sync. Then adjust the SYNC LEVEL control until the waveform "locks in." Repeat this procedure to obtain sync with the smallest possible waveform.

( ) Set the signal generator to produce a 100 kHz 1-volt sine wave.

( ) Set the HORIZONTAL frequency switch to 10 kHz – 100 kHz position.

( ) Adjust the FREQ VERN control to display approximately 6 cycles.

( ) Slowly reduce the generator amplitude. If the waveform loses sync, carefully readjust the SYNC LEVEL control until the waveform "locks in."

( ) Set the signal generator to produce a 1 kHz square wave.

( ) Adjust the generator amplitude to produce approximately 4 cm of vertical deflection.

( ) Set the HORIZONTAL frequency switch to the 100 – 1 kHz position.

( ) Turn the FREQ VERN control to display several cycles.

Figure 5 shows the waveforms for the correct amount of circuit compensation, too little compensation, and too much compensation respectively. When making the following adjustments, the waveform should look like Part A of Figure 5.

( ) Adjust the X10 trimmer capacitor until the waveform appears as shown in Part A of Figure 5.

( ) Turn the VERTICAL attenuator switch to AC X100.

( ) Adjust the X100 trimmer capacitor until the waveform appears as shown in Part A of Figure 5.

( ) Set the VERTICAL attenuator switch to AC X10.

( ) Set the HORIZONTAL frequency switch to the 10 kHz – 100 kHz position.

( ) Set the signal generator to produce a 100 kHz square wave.

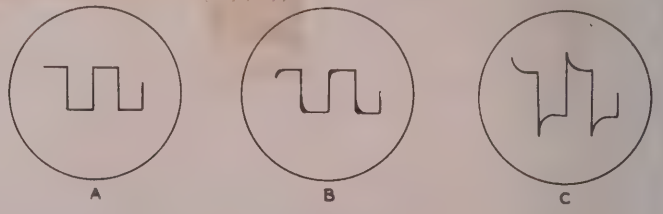


Figure 5

NOTE
DEPENDING ON THE RISE TIME OF YOUR SIGNAL GENERATOR YOU MAY OR MAY NOT SEE THE VERTICAL PORTION(S) OF YOUR SQUARE WAVE(S)

( ) Turn the FREQ VERN control to display several cycles.

( ) Adjust the VERTICAL COMPENSATION capacitor (shown on Page 63) until the waveform appears as shown in Part A of Figure 5.

( ) Adjust the ASTIGMATISM control (see Figure 2, fold-out from this page), and the INTENSITY and FOCUS controls (on the front panel) for the sharpest trace.

This completes the "Tests and Adjustments" section. Now proceed to the "Final Assembly."

Without Signal Generator

( ) Set the front panel controls as follows:

HORIZONTAL frequency switch: 100 Hz – 1 kHz position.

FREQ VERN control: center of rotation.

Horizontal GAIN control: center of rotation.

SYNC switch: EXT position.

VERTICAL attenuator switch: AC X10.

Vertical GAIN control: center of rotation.

Refer to Figure 6 for the following steps.

( ) Unplug the line cord plug and connect a 1" length of bare wire to the indicated foil on the sweep circuit board (S-1). Do not allow the wire to touch other foils or component leads.

( ) Connect the red test lead banana plug to the VERT IN banana jack. Connect the alligator clip to the 1" wire extending from the foil side of the sweep circuit board.

( ) Connect the black test lead banana plug to the EXT SYNC jack. Connect the alligator clip to the 1" wire coming from hole TP in the horizontal amplifier circuit board.

Refer to Figure 4 for the following steps.

( ) Plug in the line cord plug.

( ) Adjust the horizontal GAIN and the HORIZ POSITION controls until the display on the CRT extends from the left edge of the graticule to the right edge of the graticule.

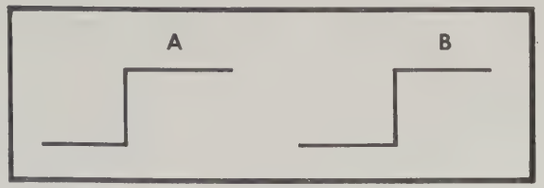


Figure 7

( ) Adjust the SYNC LEVEL control until one cycle of a square wave appears. (See Part A of Figure 7.) Then adjust the control until the waveform is symmetrical (where the positive portion of the waveform is equal to the negative portion of the waveform as in Part B of Figure 7.)

Figure 8 shows the waveforms for the correct amount of circuit compensation, too little compensation, and too much compensation respectively. When making the following adjustments, the waveform should look like Part A of Figure 8.

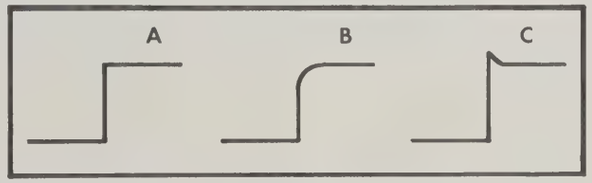


Figure 8

( ) Adjust the X10 trimmer capacitor until the waveform appears as shown in Part A of Figure 8.

( ) Turn the VERTICAL attenuator switch to AC X100 and increase the Vertical GAIN control.

( ) Adjust the X100 trimmer capacitor until the waveform appears as shown in Part A of Figure 8.

( ) Set the VERTICAL attenuator switch to AC X10.

( ) Set the HORIZONTAL frequency switch to the 1 kHz – 10 kHz position.

( ) Adjust the VERTICAL COMPENSATION CAPACITOR until the waveform appears as shown in Part A of Figure 8.

( ) Adjust the ASTIGMATISM control (see Figure 2, fold-out from this page), and the INTENSITY and FOCUS controls (on the front panel) for the sharpest trace.

( ) Unplug the line cord plug.

( ) Disconnect both the red test lead and the black test lead. NOTE: The bare wires need not be removed from the circuit boards.

This completes the "Tests and Adjustments" section. Now proceed to the "Final Assembly."

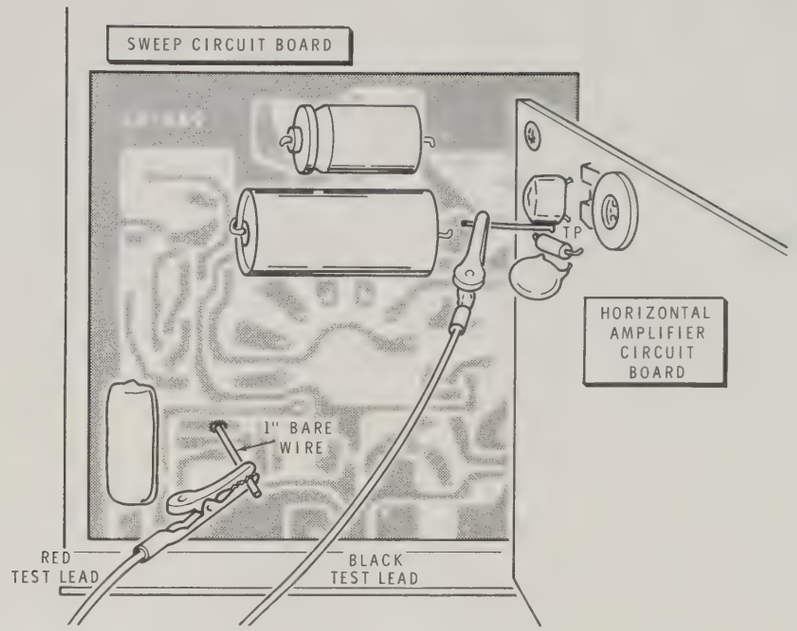


Figure 6

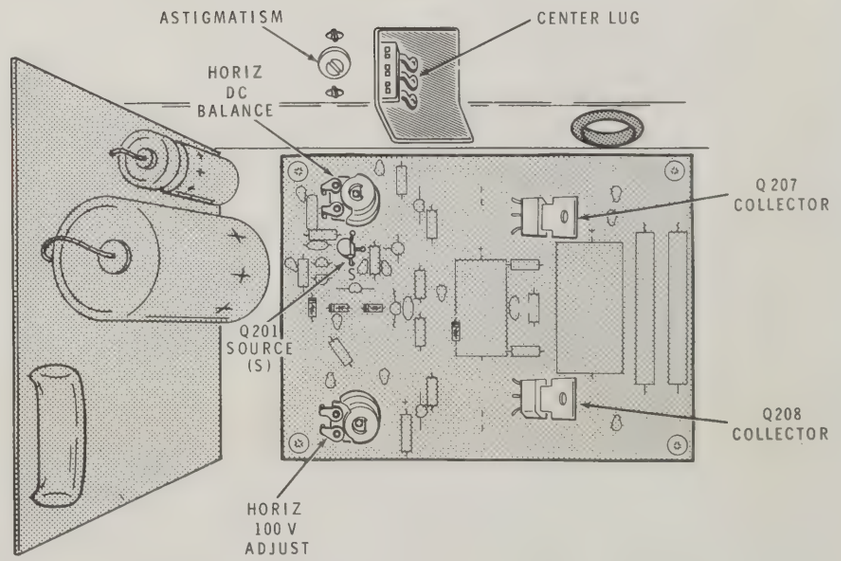


Figure 2

FINAL ASSEMBLY

Refer to Pictorial 6-1 (fold-out from Page 66) and Detail 6-1A for the following steps.

( ) Remove the backing paper from two plastic feet. Install the feet on the bottom side of one cabinet shell at the indicated locations.

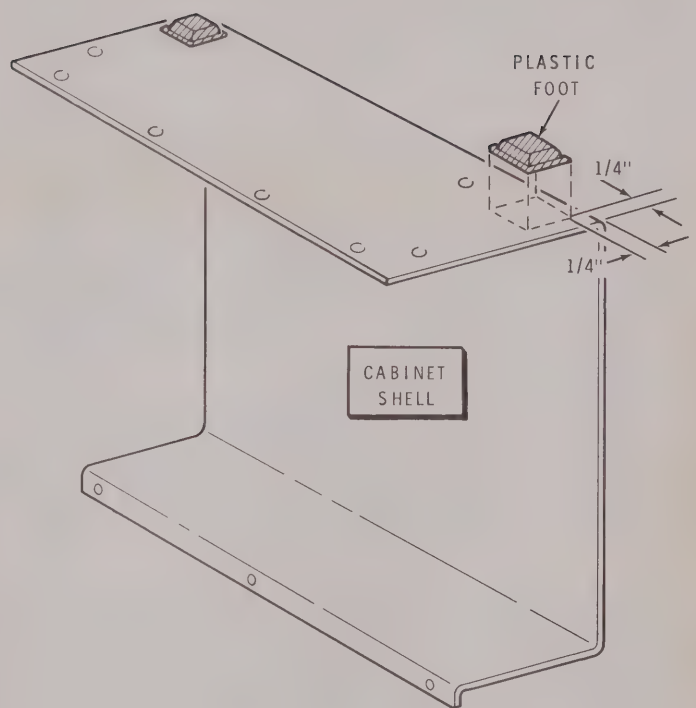
( ) Similarly, install two plastic feet on the other cabinet shell.

Refer to Pictorial 6-1 for the following steps.

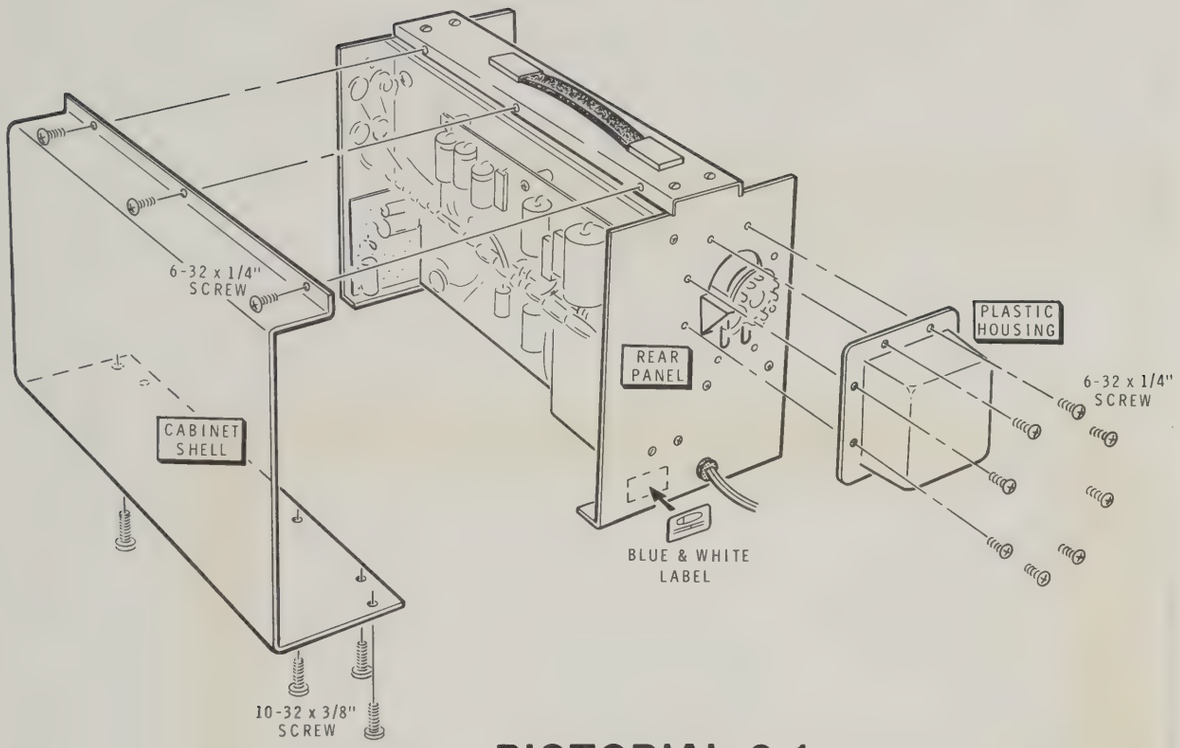
( ) Mount both cabinet shells. Use eight 10-32 x 3/8" screws and six 6-32 x 1/4" screws. Do not tighten any screws until they are all started in their holes.

( ) Mount a plastic housing to the rear panel as shown. Use eight 6-32 x 1/4" screws.

( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the rear panel in the position shown. Be sure to refer to the numbers on the label in any communications you have with the Heath Company about this kit.



Detail 6-1A



PICTORIAL 6-1

FINAL ASSEMBLY

Refer to Pictorial 6-1 (fold-out from Page 66) and Detail 6-1A for the following steps.

( ) Remove the backing paper from two plastic feet. Install the feet on the bottom side of one cabinet shell at the indicated locations.

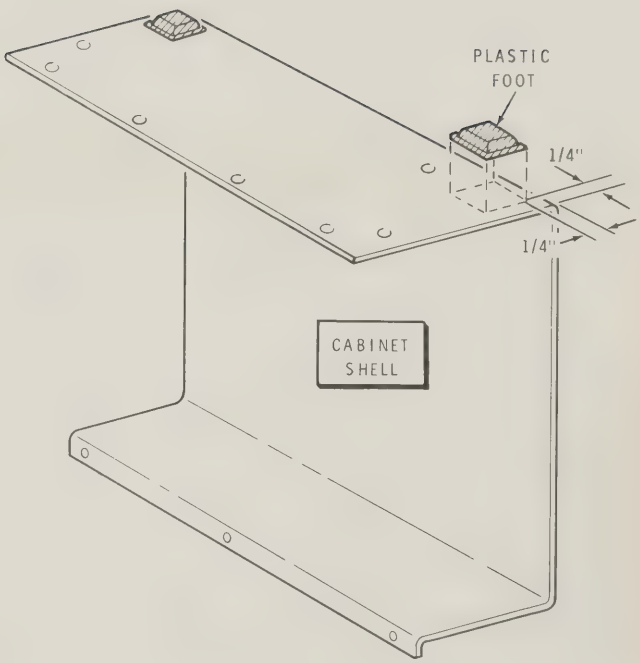
( ) Similarly, install two plastic feet on the other cabinet shell.

Refer to Pictorial 6-1 for the following steps.

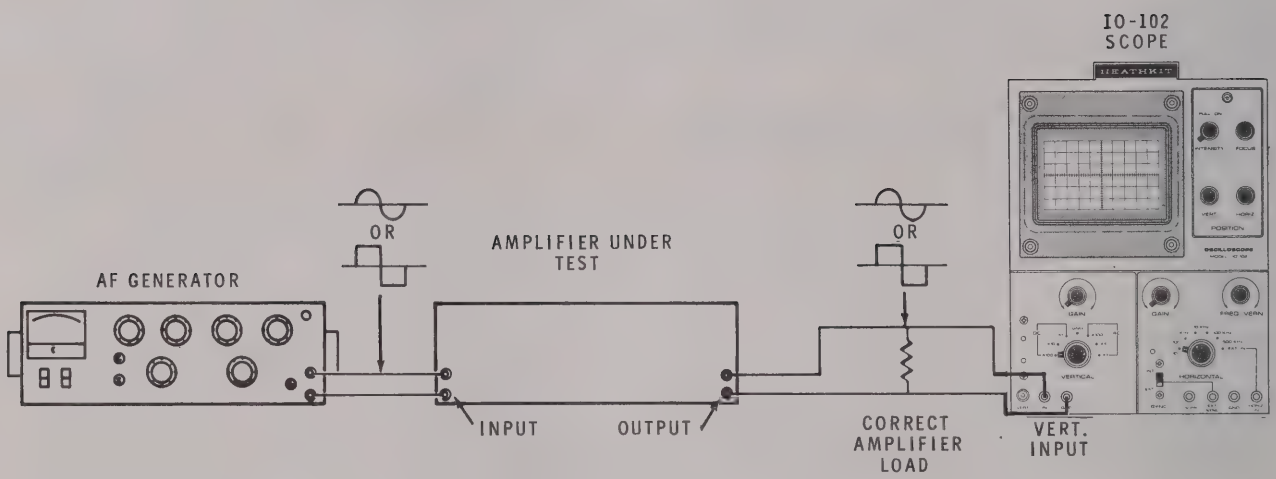
( ) Mount both cabinet shells. Use eight 10-32 x 3/8" screws and six 6-32 x 1/4" screws. Do not tighten any screws until they are all started in their holes.

( ) Mount a plastic housing to the rear panel as shown. Use eight 6-32 x 1/4" screws.

( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the rear panel in the position shown. Be sure to refer to the numbers on the label in any communications you have with the Heath Company about this kit.



Detail 6-1A


IO-102
SCOPE
OR
AMPLIFIER UNDER
TEST
OR
AF GENERATOR
INPUT
OUTPUT
CORRECT
AMPLIFIER
LOAD
VERT.
INPUT

OPERATION AND APPLICATIONS

The "Test and Adjustments" section of this Manual introduced you to the Operation of your Scope (see Figure 1, fold-out from Page 60). This section will help you obtain the greatest use from your instrument by showing you various uses and applications for it.

NOTE: Your Oscilloscope has highly sensitive dc amplifiers. It is therefore normal for the trace to drift vertically somewhat during the first half hour or so after it is turned on. Occasionally, the DC BALANCE CONTROL should be readjusted (see the boxed-in step on Page 62). Perform this adjustment carefully.

The Oscilloscope's ability to display many types of voltage waveforms permits the study of complex signals, such as found in audio, television, transmitter, and other electronic circuits. Voltage, frequency, and phase can also be measured with an oscilloscope.

This section of the Manual presents some fundamental oscilloscope applications. These will help you to become familiar with the instrument to achieve the greatest use of it.

WAVEFORM DISPLAY

Lines or waveforms appear on the face of a cathode ray tube (CRT) when its electron beam is deflected by varying charges on its deflection plates. Generally, an internal sweep generator in the oscilloscope varies the charge on the horizontal deflection plates and moves the beam rapidly from side to side. Horizontal sweep can also be produced by applying an external sweep signal to the Horizontal Input of the oscilloscope.

Vertical deflection results from a signal applied to the Vertical Input of the oscilloscope. This signal is amplified and applied to the vertical deflection plates in the CRT.

When the frequency of the vertical input signal is equal to the horizontal sweep frequency, one complete cycle will be displayed on the screen. If the signal frequency is higher than the sweep frequency, more than one cycle will be displayed. The height of the waveform on the screen will be proportional to the amplitude of the vertical input signal, although affected by the setting of the vertical GAIN control and Attenuator switch.

With this very brief theory of operation, you can see that an oscilloscope will display the waveform of the signal voltage that is fed to its Vertical Input. The signal voltage may be taken from an audio amplifier, a television receiver, a transmitter, or almost any electronic circuit. Some of the more common oscilloscope applications are described in the following paragraphs.

AUDIO AMPLIFIER CIRCUITS

You can observe frequency response, distortion, and gain in an audio amplifier by observing its output waveform when a sine wave or square wave is applied to its input.

Figure 9 shows a typical setup for checking an audio amplifier. The audio generator injects either a sine wave or square wave signal into the input of the amplifier. The amplifier's output terminates in a proper load impedance, and the oscilloscope is connected across the load.

Normal input and output waveforms are also shown in Figure 9.

The waveform produced by the audio generator will not be changed as it passes through properly operating circuits of a high fidelity amplifier. However, if any circuit is not operating properly, the output waveform will be distorted.

Figure 10

Figure 10A shows a sine wave with a serious flattening of one peak. This represents about 10% harmonic distortion, which could be caused by an improperly biased stage or a defective tube or transistor in a push-pull stage. Figure 10B indicates third harmonic distortion, which is a particularly objectionable amplifier fault. Figure 10C shows a flattening of both peaks, which usually indicates an overdriven stage somewhere in the amplifier.

While a sine wave signal will tell a lot about an amplifier, a square wave signal gives a very accurate indication of amplifier performance with respect to frequency response, amplitude distortion, and phase shift. The square wave generator must produce a clean waveform with straight sides, sharp corners, and flat horizontal lines, as shown in Figure 11A.

Figure 11

When a low frequency square wave signal is fed into the input of an amplifier, its output waveform will be a faithfully reproduced square wave if its frequency response is good and if little amplitude or phase distortion occurs in its circuits. The shape of the leading edge of an output waveform, as shown in Figure 11B, indicates poor high frequency response. This may be caused by amplitude distortion or phase shift, or both.

The slope of the flat portion of the waveform, as shown in Figure 11C, indicates low frequency response.

When making square wave tests of an amplifier, be sure the generator used produces clean waveforms, and has good voltage regulation.

TELEVISION RECEIVER CIRCUITS

Another application of the cathode ray oscilloscope is the servicing of television receivers. There are two methods of using the oscilloscope in TV service work. One is the point-to-point probing to study components of a transmitted television signal and their effect on receiver circuits. The other method uses the signal from a sweep generator and is used primarily for the alignment of a receiver. These two methods will be treated separately in the following paragraphs.

Point-to-Point Signal Tracing

Most television manufacturers supply service information that shows correct oscilloscope patterns at various points in the receiver. These patterns are generally of the composite video signal or synchronizing signals that are received from a television transmitter, or generated within the receiver. Some of these patterns are shown in Figure 12, with the signal frequency indicated for each pattern. No special equipment is required for observing these patterns on your oscilloscope, except a demodulator probe to detect modulation envelopes in the i-f or rf amplifier sections.

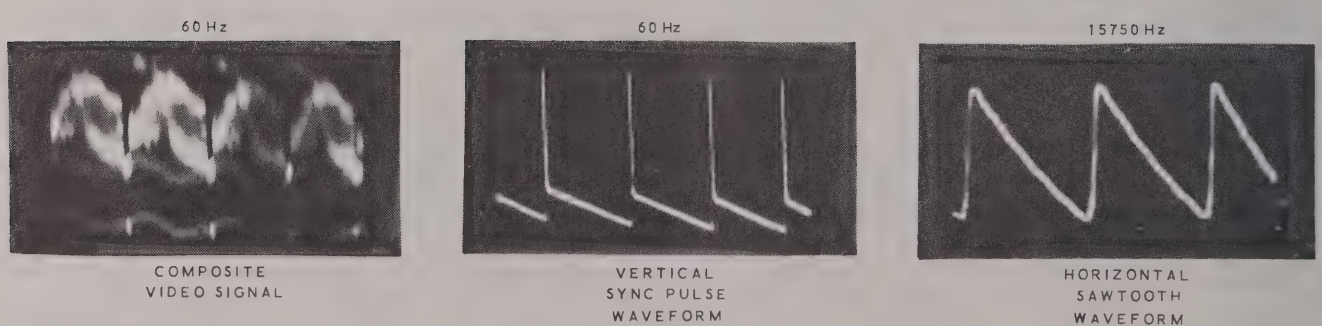


Figure 12

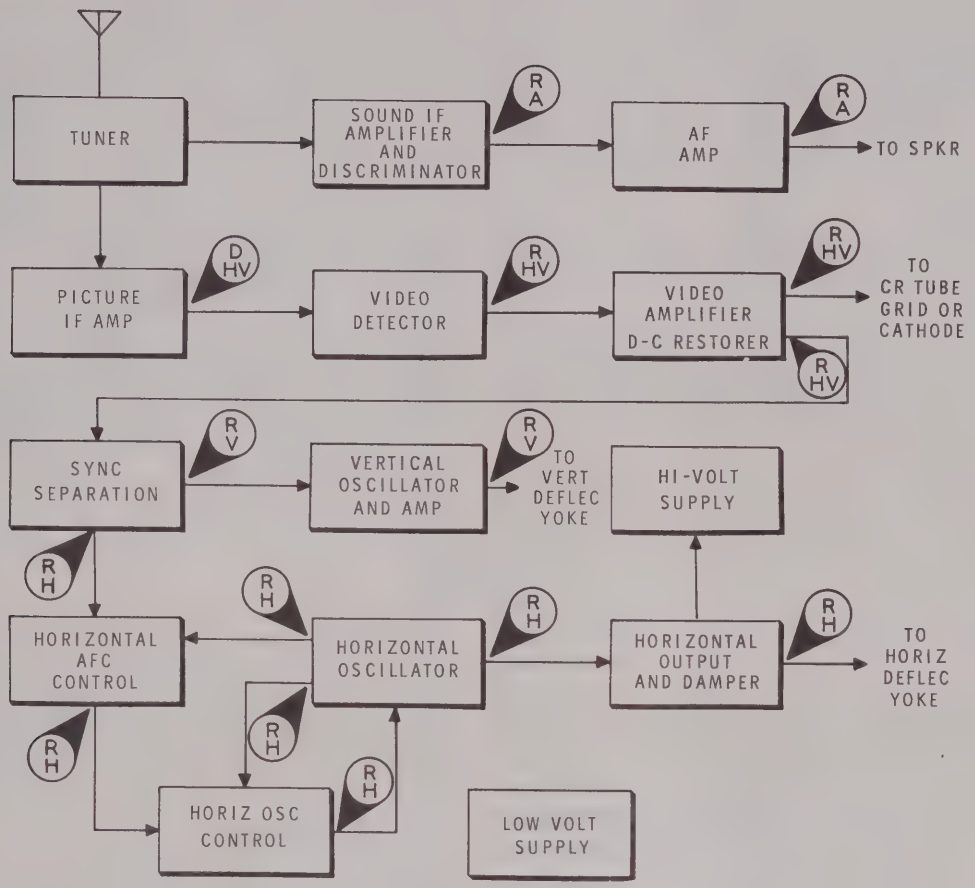


Figure 13

Figure 13 is a simplified block diagram of a typical television receiver. It shows various stages and points for connecting the oscilloscope probe. The letters at each test point indicate the type of probe to use, and the setting of the oscilloscope's sweep frequency. These letters are defined in the following chart.

PROBE	SWEEP FREQUENCY
R Direct	H 7,875 or 15,750 Hz
D Demodulator	V 20, 30, or 60 Hz
	A Audio test frequency

NOTE: For simplicity, all amplifier stages are shown within one block in the diagram in Figure 13. Tests may be made at the input or output of individual amplifier stages using the indicated probe and sweep frequency.

At any point up to the video detector, the voltages will be quite small and considerable vertical gain will be required. Within the sync circuits and deflection circuits, however, these voltages are larger and very little amplification is required.

In checking the waveforms, remember that two basic frequencies are involved in the television signal. The vertical or field frequency is 60 Hz. Any investigation of the circuit except within the horizontal oscillator, its differentiator network, and the horizontal amplifier stages, can generally be made using a sweep frequency of 20 or 30 Hz, thus showing two or three complete fields of the signal. In order to study the horizontal pulse shape or the operation of the horizontal deflection system, it is generally necessary to operate the sweep generator at 15,750 or 7,875 Hz. This sweep rate will show the waveform of one or two complete lines of the signal.

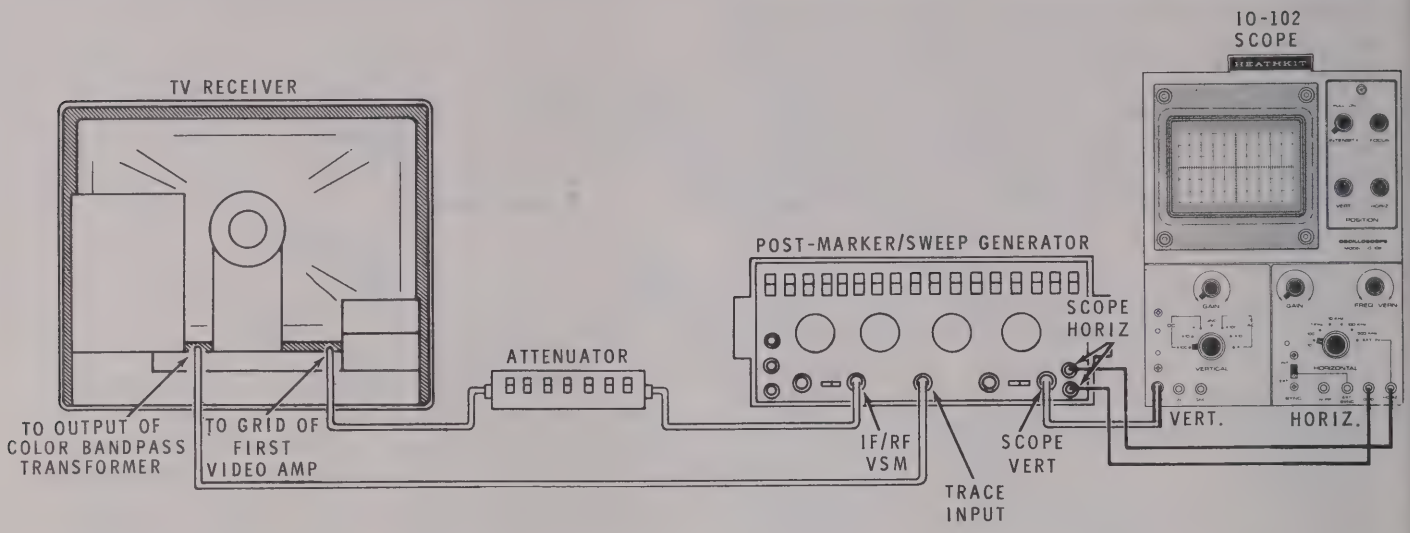


Figure 14

The point-to-point signal tracing method of analysis is most helpful in going through a receiver, since faulty receiver operation is generally caused by the loss of all or a significant portion of the picture information and pulses at some stage within the receiver. With a basic understanding of the function of each part of the signal and with a knowledge of what the signal actually looks like at any part of the receiver, it is a comparatively simple matter to isolate the defective portion and the particular component causing the failure.

Bear in mind that a phase shift of 180 degrees takes place in some circuits of a receiver. Therefore, the pattern displayed on the oscilloscope screen may be inverted in some cases. The pattern or form of the wave should not be changed however.

Video amplifier response can be measured in exactly the same manner described for testing an audio amplifier and again a square wave signal is the most efficient method to use. Because a video amplifier must pass signals as low as 20 Hz and as high as 4 or 5 megahertz, a more comprehensive test is required. Usually a 60 Hz check is made to cover low and medium frequency characteristics. A second check at 25 kHz covers the high frequency portion of the response curve. Again such tests require accuracy on the part of the oscilloscope. The signal tracing technique can be used in these tests also. The square wave generator is fed directly into the first video amplifier stage. Very low signal input will be required. Then, the oscilloscope is connected to various stages starting near the output end and working back until any distortion is isolated. Patterns such as Figure 11B (on Page 70) are responsible for poor picture detail or fuzziness, while distortion of the waveform shown in Figure 11C can cause shading of the picture from top to bottom.

Receiver Alignment

Alignment of television rf and i-f circuits requires the use of an alignment sweep generator as well as the oscilloscope. The sweep generator supplies an rf signal that sweeps across all the frequencies of a television channel or i-f amplifier 60 times per second. The sweep generator also supplies this 60 Hz sweep voltage to the Horizontal Input of the oscilloscope. Figure 14 shows a typical setup for the alignment of a television receiver.

The exact procedure for alignment differs with various receivers and with different sweep generators. Manufacturer's service data usually includes alignment procedure and correct response waveforms.

Figure 15A shows a typical response curve for a properly aligned receiver.

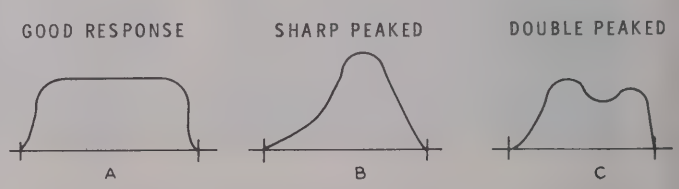


Figure 15

Notice that the top part of the waveform is essentially flat, and tapers sharply at both ends. The waveform shown in Figure 15B might result if the i-f stages of the receiver were aligned too sharply or all at the same frequency. This would produce a narrow bandwidth and seriously affect picture quality. A misalignment of one or more i-f stages would produce a waveform like that shown in Figure 15C, which would also reduce picture quality.

AC VOLTAGE MEASUREMENTS

Because of its characteristics, the oscilloscope is particularly suited to the measurement of ac voltages. In some television circuits it is imperative that such measurements be made accurately without respect to wave shape, so that the conventional rms-indicating ac voltmeter is no longer adequate. Most television service bulletins specify peak-to-peak voltages which appear at various points of the circuit.

The oscilloscope can be used to display and accurately measure these voltages. It can be easily calibrated for this purpose by using a known accurate external ac voltage source or, in the case of this Oscilloscope, the built-in 1 volt peak-to-peak reference source. To calibrate the oscilloscope, connect the Vertical Input lead to the reference voltage source (the 1 V P-P jack). Adjust the vertical GAIN control until the waveform on the screen reaches the height of one division line. Now, as long as the vertical GAIN control remains unchanged, the pattern height of any vertical input signal up to 6 volts peak-to-peak can be read in relation to the 1 volt reference line on the graticule. By switching the VERTICAL Attenuator switch to the x10 and x100 positions, voltages up to 60 and 600 volts peak-to-peak can be measured.

The oscilloscope can be calibrated for measuring higher voltages by using an external ac voltage standard, or by using a lower 1 volt reference mark on the graticule.

The following relationships exist for sine wave ac voltages:

rms x 1.414 = Peak Voltage
rms x 2.828 = Peak-to-Peak Voltage
Peak Voltage x 0.707 = rms Voltage
Peak-to-Peak Voltage x 0.3535 = rms Voltage.

DC VOLTAGE MEASUREMENTS

Oftentimes it is important that a dc voltage be measured or that an ac signal be observed on a certain dc level. To check either of these conditions, set the VERTICAL attenuator switch to the GND position. Then, with the VERTICAL position control, position the trace to the center division line on the screen. Turn the VERTICAL attenuator switch to one of the three dc positions and apply a known dc voltage to the vertical input. Adjust the vertical GAIN control until the trace is at a convenient position on the screen. Then, when the scope is connected to an unknown dc voltage, the trace will rise or drop to a position that is a function of the known voltage.

Example: If 9 volts dc was used to cause the trace to rise one division, then 18 volts will cause the trace to rise two divisions, and 4-1/2 volts will cause the trace to rise 1/2 division above the center line on the screen.

FREQUENCY MEASUREMENTS

Frequency measurements can be made with an accuracy limited only by the reference source available. At times, this can be the 60 Hz line frequency which is usually controlled very closely. The unknown frequency is applied to the vertical input and the reference frequency to the horizontal input. The internal sweep generator is not used. The resultant pattern may take on any one of a number of shapes. Typical patterns are shown in Figure 16. These patterns are called Lissajous figures. They are obtained when sinusoidal ac voltages are applied simultaneously to the two sets of oscilloscope deflection plates. The resultant pattern depends upon the relative amplitudes, frequencies, and phase of the two voltages.

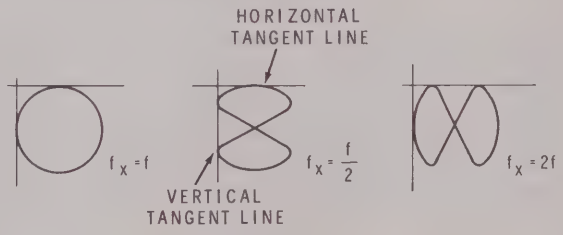


Figure 16

The frequency ratio can be calculated from the formula:

$$f_x = \frac{Th \times f}{Tv};$$

where f_x is the unknown frequency. Th is the number of loops which touch the horizontal tangent line; Tv is the number of loops which touch the vertical tangent line; f is the known frequency.

When using Lissajous figures, it is good practice to have the figure rotating slowly rather than stationary. This eliminates the possibility of an error in counting the tangent points. If the pattern is stationary, a double image may be formed. In such cases, the end of the trace should be counted as one-half a tangent point rather than a full point. This condition may occur when neither frequency can be varied.

Figure 17

PHASE MEASUREMENTS

It is sometimes necessary to determine the phase relationship between two ac voltages of the same frequency. This can be accomplished quite easily by applying one of the voltages to the horizontal input and the other voltage to the vertical input. The phase relationship can be estimated from Figure 17.

NOTE: For proper displays the horizontal amplifier gain must be set equal to the vertical amplifier gain.

To calculate the phase relationship, use the following formula:

$$\text{Sin } \theta = \frac{A}{B}$$

As shown in Figure 18, the distance A is measured from the X axis to the intercept point of the trace and the Y axis. The distance B represents the heights of the pattern above the X axis. The axis of the ellipse must pass through the point O.

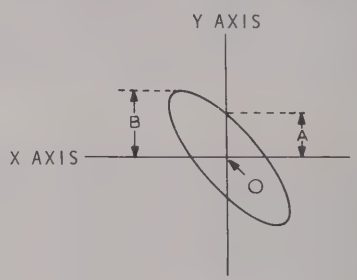


Figure 18

IN CASE OF DIFFICULTY

This section of the Manual is divided into three parts. The first part, titled "General Troubleshooting Information," describes what to do about difficulties that may occur right after the kit is assembled.

The second part, titled "Finding the Area of Trouble," describes a method for locating trouble in the differential amplifiers.

The third part, a "Troubleshooting Chart," is provided to assist in servicing if the general information does not clear up the problem, or if difficulties occur after the Instrument has been in operation for some time. This chart lists a number of possible difficulties that could arise, and lists several possible causes.

Before starting any troubleshooting procedure, try to narrow the problem down to a specific area by trying the various functions of the Instrument.

General Troubleshooting Information

The following paragraphs deal with the types of difficulties that may show up right after a kit is assembled. These difficulties are most likely to be caused by assembly errors or faulty soldering. These checks will help you locate any error of this type that might have been made.

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.

2. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the "Soldering" section of the "Kit Builders Guide."

3. Check to be sure that all transistors are in their proper locations. Make sure each transistor lead is connected to the proper point.

4. Check the values of the parts. Be sure that the proper part has been wired into the circuit as shown in the pictorial diagrams and called out in the wiring instructions.

5. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring. Check for solder bridges between circuit board foils. Compare your foil pattern against the "X-Ray Views" on Page 84.

Finding the Area of Trouble

A review of the "Circuit Description" and "Block Diagram" will prove helpful in locating the trouble.

If after careful checks, the trouble is still not located and a voltmeter is available, check the voltage readings against those shown on the Schematic Diagram. NOTE: All voltage readings were taken with an 11 megohm input voltmeter. Voltages may vary as much as ±20%.

Because most of the circuits are dc coupled, it is almost impossible to list troubles in a "cause and effect" type of chart. For example, a saturated transistor on one side of a differential amplifier may appear as a trouble on the other side. However, a Troubleshooting Chart is provided to help you isolate the problem to a particular area of the Oscilloscope.

Since the Position controls are at the front of each differential amplifier and affect each succeeding stage, they serve as troubleshooting aids. When troubleshooting the vertical amplifier, for instance, first check the associated power supply voltages. Then check the collector voltage of transistors Q9 and Q10. These voltages should vary as the Vertical position control is turned. If these voltages change accordingly, the trouble may be in the CRT circuit. If the voltages do not change, the problem is in either Q9 or Q10, or the preceding stages. Move the voltmeter to the preceding stage (Q7 and Q8) and repeat the procedure until the trouble is located.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Service" section and the Warranty in the "Kit Builders Guide" and to the "Factory Repair Service" information on Page 77 of this Manual.

Troubleshooting Chart

Difficulty	Possible Area of Trouble
Neither pilot lamp nor CRT filaments light.	1. Fuse blown. 2. On-Off switch. 3. No ac power from outlet.
Pilot lamp lights, CRT filament does not light.	1. Power transformer. 2. CRT.
No spot or trace on CRT.	1. Positioning or intensity controls improperly adjusted. 2. High voltage power supply. 3. CRT.
Dot cannot be centered vertically.	1. Vertical Position control and associated circuit.
Dot cannot be centered horizontally.	1. Horizontal Position control and associated circuit.
No vertical deflection.	1. Vertical amplifier.
No horizontal deflection.	1. Horizontal amplifier.
Poor focus.	1. CRT. 2. Focus control. 3. Astigmatism control. 4. Resistors R412, R413, R414, and R303.
Trace acts erratic when the window is touched.	1. Clean the window with detergent to eliminate static charge.
Cannot synchronize input signal with sweep generator frequency.	1. Sync switch in the EXT position. 2. Control R103 misadjusted.
No retrace blanking or poor retrace blanking.	1. Transistor Q108. 2. Diode AZ101.
Pilot lamp changes intensity from bright to dim.	1. This is normal operation.

FACTORY REPAIR SERVICE

You can return your completed kit to the Heath Company Service Department to have it repaired for a minimum service fee. (Kits that have been modified will not be accepted for repair.) Or, if you wish, you can deliver your kit to a nearby Heathkit Electronic Center. These centers are listed in your Heathkit catalog.

To be eligible for replacement parts under the terms of the warranty, equipment returned for factory repair service, or delivered to a Heathkit Electronic Center, must be accompanied by the invoice or the sales slip, or a copy of either. If you send the original invoice or sales slip, it will be returned to you.

If it is not convenient to deliver your kit to a Heathkit Electronic Center, please ship it to the factory at Benton Harbor, Michigan and observe the following shipping instructions:

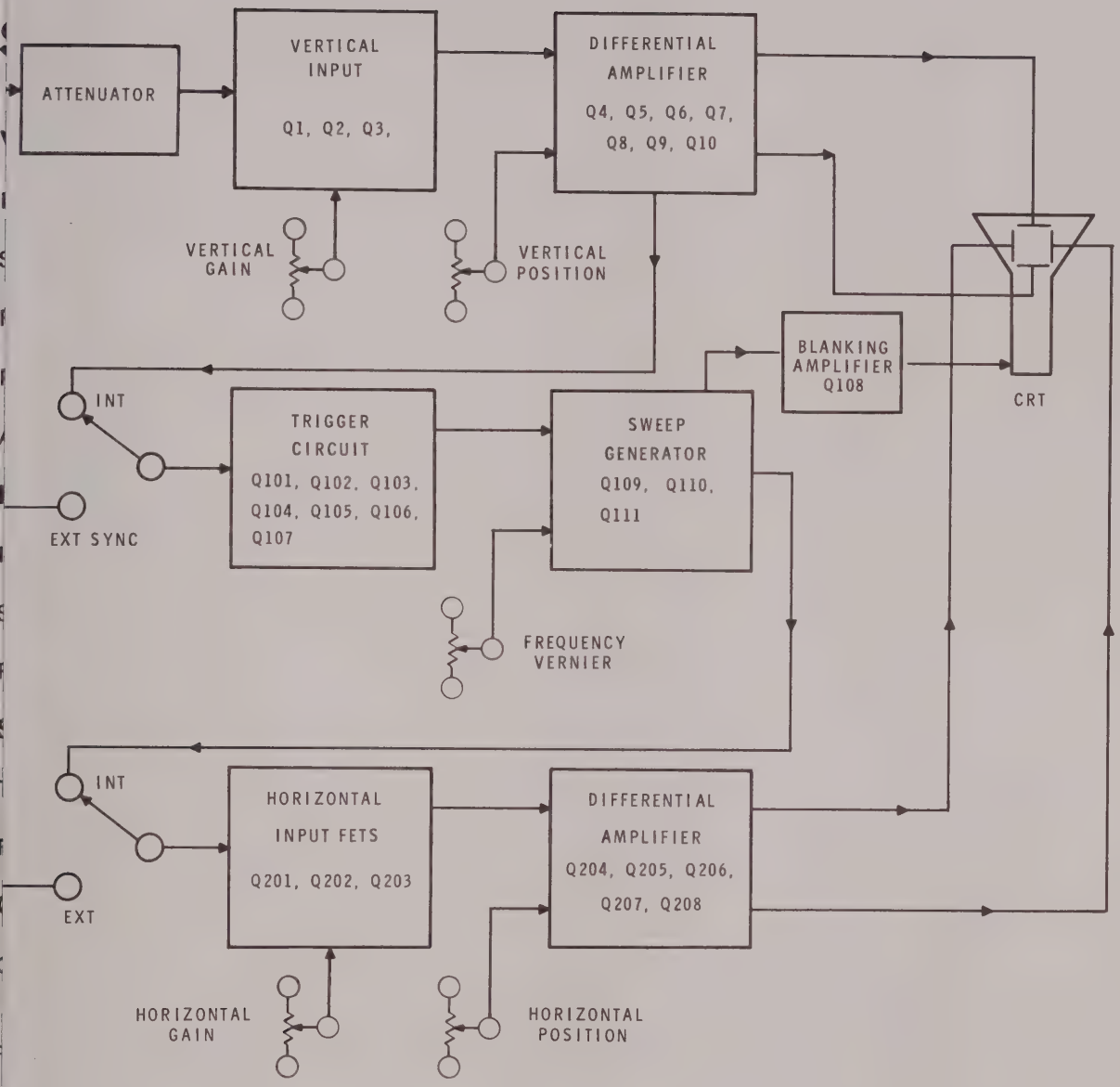
Prepare a letter in duplicate, containing the following information:

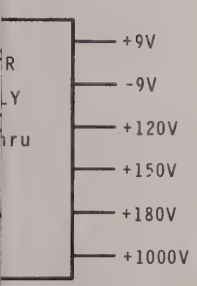
- Your name and return address.
- Date of purchase.
- A brief description of the difficulty.
- The invoice or sales slip, or a copy of either.
- Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the warranty.

Attach the envelope containing one copy of this letter directly to the unit before packaging, so that we do not overlook this important information. Send the second copy of the letter by separate mail to Heath Company, Attention: Service Department, Benton Harbor, Michigan.

Check the equipment to see that all parts and screws are in place. Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least THREE INCHES of resilient packing material (shredded paper, excelsior, etc.) on all sides, between the equipment and the carton. Seal the carton with gummed paper tape, and tie it with a strong cord. Ship it by prepaid express, United Parcel Service, or insured parcel post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022





BLOCK DIAGRAM

SPECIFICATIONS

VERTICAL CHANNEL

Input Impedance	1 megohm shunted by 35 pF.
Sensitivity	30 mV peak-to-peak/centimeter (uncalibrated).
Frequency Response	DC to 5 MHz ±3 dB.
Rise Time	80 nanosecond.
Attenuator	3 position, compensated, X1, X10, X100.

HORIZONTAL CHANNEL

Input Impedance	1 megohm shunted by 50 pF.
Sensitivity	.1 volt/centimeter.
Frequency Response	1 MHz ±3 dB.

SWEEP GENERATOR

Type	Recurrent, automatic sync.
Range	10 Hz to 500 kHz in five ranges.

GENERAL

CRT	5DEP1, 6 x 10 centimeter viewing area, green, medium persistence phosphor.
Power Supplies	All solid-state rectifiers. All amplifier supplies regulated.
Power Requirements	110-130 or 220-260 Vac 50/60 Hz 70 watts.
Overall Dimensions	12-3/4" high, 9-1/4" wide, 16-1/4" long. These dimensions include all protruding surfaces; knobs, handle, feet, etc.
Net Weight	27 lbs.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram (fold-out from Page 99) and the Block Diagram (fold-out from Page 80) while reading this Circuit Description.

To help you locate specific parts in the Oscilloscope or on the Schematic, the resistors, capacitors, transistors, and diodes are numbered in the following groups.

0-99	Parts mounted on the vertical circuit board.
100-199	Parts mounted on the sweep circuit board.
200-299	Parts mounted on the horizontal circuit board.
300-399	Parts mounted on the power supply circuit board.
400-499	Parts mounted on the chassis.

VERTICAL AMPLIFIER

A signal applied to the Vert In connector is coupled through the frequency-compensated attenuator network. Capacitor C401 blocks the dc when the Vertical switch is in the AC positions. From the attenuator circuit, a portion of the input signal is coupled through resistor R1 and capacitor C1 to the gate of transistor Q1. Resistor R1 protects Q1 from being damaged in case a high potential is applied to the Vert In connector while the Vertical switch is in one of its lower ranges. Diodes D1 and D2 are transistors connected to provide a zener action. These diodes limit the input signal to approximately ±9 volts, which further protect Q1 from excess gate voltage. Capacitor C1 improves high frequency response by forming a high frequency path around R1.

Transistor Q1 is a field effect transistor (FET) connected as a source follower. This type of transistor provides the high impedance input necessary to prevent loading.

Transistor Q2 is a constant current source for input transistor Q1. Diodes D4 and D5 each provide a .6 volt drop (total 1.2 volts) and hold the base of Q2 at a constant voltage. Since the circuit of transistor Q2 is basically an emitter follower (common-collector) and the emitter voltage is dependent upon the base voltage, the emitter voltage will also remain constant. This constant emitter voltage is across emitter resistor R2; therefore, the current through R2 is constant. Resistor R2 is adjusted so the source voltage of Q1 is zero when an input signal is not present.

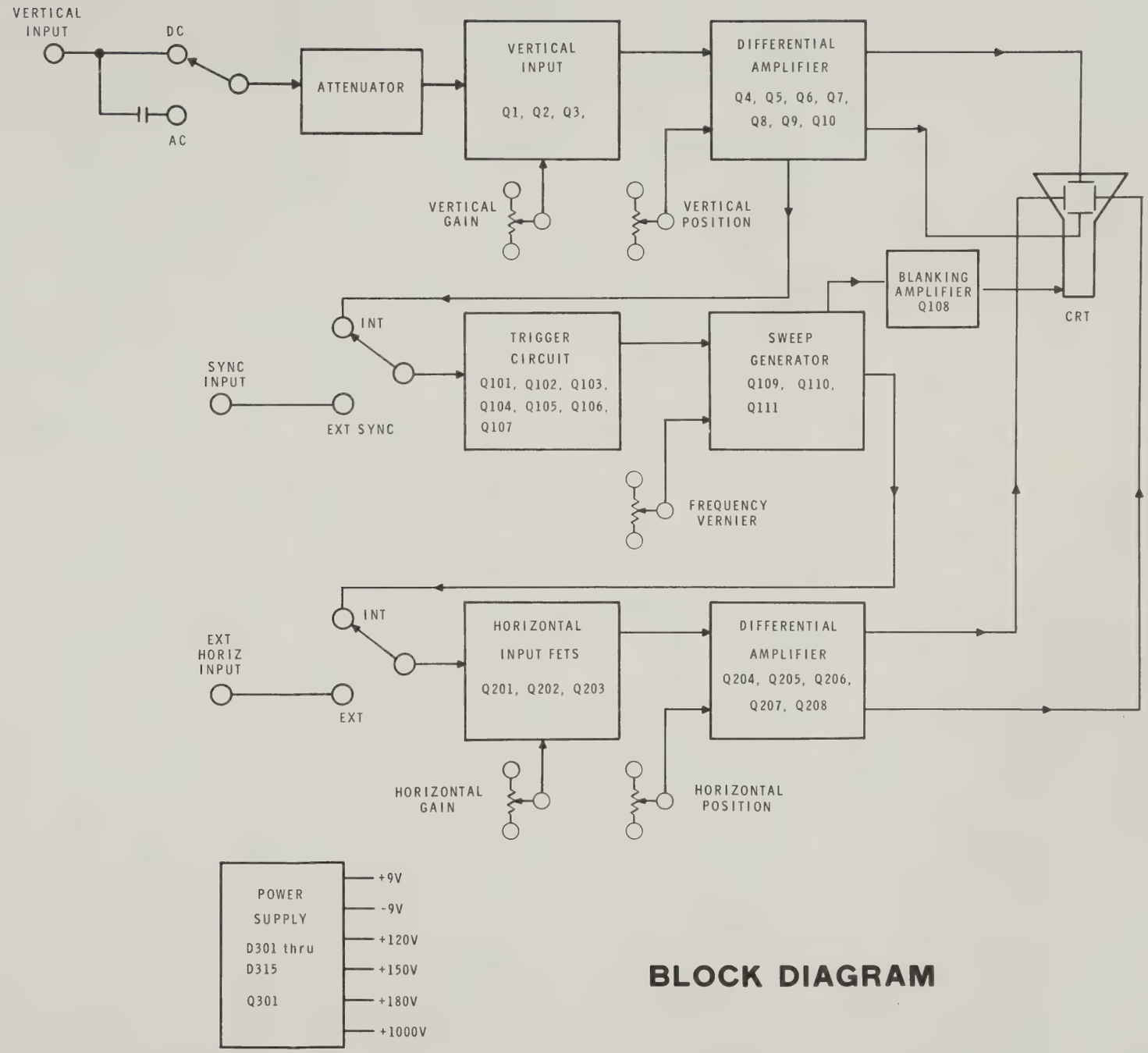
A signal applied to the gate of Q1 will cause only voltage changes at the source because the current through Q1 is constant. These voltage variations are applied across Gain control R404, and a portion of this signal is applied to the gate of source follower Q3.

Transistor Q4 forms a constant current source for transistors Q5 and Q6. Since the emitter of each transistor is connected to this constant current source,the current source serves as a common emitter resistance and sets the operating point for the following stages.

The output from source follower transistor Q3 is amplified by Q5. A portion of the signal applied to the base of Q5 appears at its emitter. Because transistors Q5 and Q6 have a common emitter resistance, the signal present at the Q5 emitter is effectively coupled to the emitter of Q6.

Transistor Q6 functions as a common base amplifier whose base is held constant by the Vertical Position control R406. This control positions the trace by applying a dc voltage to the base of transistor Q6, causing a dc unbalance in the vertical amplifier. When the collector output voltage of Q5 decreases, its emitter voltage will increase. An increased emitter voltage at Q6 reduces its forward bias and increases its collector output voltage. The signal at the collector of transistor Q6 is 180 degrees out of phase with the signal at the collector of Q5, forming a "push-pull" type of amplifier required to drive the CRT deflection plates. Capacitor C3 is an emitter bypass capacitor to boost the gain at high frequencies. Emitter resistors R8 and R9 establish the dc gain of the vertical amplifier.

Driver transistors Q7 and Q8 are common emitter amplifiers. In addition to providing gain, they also isolate transistors Q5 and Q6 from the output stages. Capacitor C4 ac couples the emitters of Q7 and Q8 at high frequencies and improves the high frequency response.



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Driver transistors Q7 and Q8 are common emitter amplifiers. In addition to providing gain, they also isolate transistors Q5 and Q6 from the output stages. Capacitor C4 ac couples the emitters of Q7 and Q8 at high frequencies and improves the high frequency response.

Output amplifiers Q9 and Q10 again amplify the differential signal and drive the vertical plates of the CRT.

SWEEP GENERATOR

The Sync switch selects either a portion of the amplified vertical input signal or a signal applied to the External Sync connector. The selected signal is then coupled to the gate of source follower Q101. (D102 and D103, transistors operated as diodes, protect transistor Q101 from high voltages by zenering at ±9 volts.) Constant current source Q102 is adjusted by the Sync Level control R103 to provide proper biasing of the sync circuits. This insures that even a small signal can sync the sweep generator.

Transistors Q103 and Q104 amplify the signal and apply it to the Schmitt trigger circuit consisting of Q105 and Q106. The Schmitt trigger circuit is a regenerative bistable circuit which produces a rectangular pulse output each time it is triggered and reset.

Transistors Q109 and Q110 form an astable multivibrator. When transistor Q110 is conducting and Q109 is cutoff, one or more of the timing capacitors (C114 through C118) are charged through transistor Q110. As the voltage at the emitter of Q110 approaches the voltage at the base, as a result of the charging capacitor, Q110 will cut off and drive Q109 into conduction. The charged timing capacitor will now discharge through the constant current source circuit of Q111. The setting of the Frequency Vernier control R407 determines the current flowing through Q111, which, in turn, determines the discharge current (and discharge time) of the timing capacitor. As the timing capacitor discharges, a positive going ramp voltage (sawtooth) is generated and coupled to the horizontal amplifier. The frequency of the horizontal sweep is determined by the particular timing capacitor selected by the Frequency Range switch and the discharge current.

Since transistors Q107 and Q109 have a common emitter resistor, a signal applied to the base of Q107 is emitter coupled to transistor Q109. The pulse output (sync signal) of the Schmitt trigger Q106, is coupled to Q109. This causes Q109 to turn on and Q110 to cut off and start the sweep just prior to the time it would normally begin.

When the signal at the emitter of Q109 goes positive, a positive pulse is coupled through capacitor C107 to the base of blanking amplifier Q108.

A negative-going output pulse is coupled through capacitor C109 to the grid of the CRT. This pulse turns off the electron beam during retrace preventing the retrace from appearing on the CRT.

HORIZONTAL AMPLIFIER

Operation of the horizontal amplifier is similar to that of the vertical amplifier. The major difference is that the horizontal amplifier does not have a PNP amplifier stage (Q7 and Q8 in the vertical amplifier).

The positive-going ramp voltage (sawtooth) from the sweep generator is amplified and applied to the horizontal plates of the CRT. This increasing voltage causes the electron beam to sweep across the face of the CRT producing a visible trace. The sweep rate of the electron beam is determined by the sawtooth frequency.

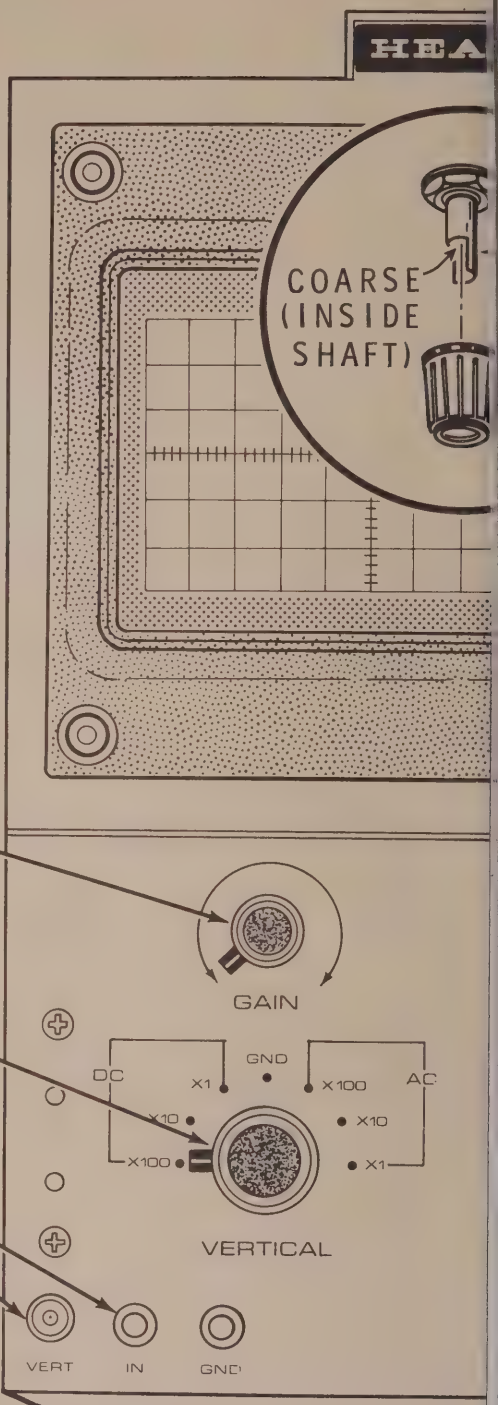
POWER SUPPLY

Line voltage is connected through the slow-blow fuse and the On-Off switch to the primary windings of the power transformer. The dual-primary transformer windings may be connected in parallel for 120-volt operation or in series for 240-volt operation. 240-volt operation is common in foreign countries.

A high voltage secondary winding of the power transformer is connected to the voltage doubler circuit consisting of D301, D302, C302, and C303. Capacitor C301 filters this negative high voltage which is fed through resistor R416 to the grid of the CRT. The intensity and focusing voltages are also supplied to the CRT from the voltage divider network consisting of resistors R412, R413, R414, and R303. A separate 6.3-volt winding supplies the CRT filament voltage.

Optimum focus is obtained when the CRT deflection plates and the astigmatism grid are at the same potential. Since the vertical deflection plate voltages (collectors of Q9 and Q10) are adjusted to 100 volts dc by constant-current source Q4, the astigmatism voltage is also adjusted to 100 volts dc.

A low voltage secondary winding is connected to the full-wave bridge rectifier circuit consisting of diodes D304, D305, D306, and D307 and capacitor C304. Zener diode ZD303 and resistor R312 maintain a constant voltage to the base of pass transistor Q301. Figure 19 shows a simplified schematic of this power supply. The output voltage is regulated at 36 volts by the series pass transistor Q301 and zener diode ZD303. By connecting equal loads from each side of the supply to ground, two separate supplies are obtained: +9 volts dc and -9 volts dc.



VERTICAL GAIN CONTROL.

Increases or decreases the vertical height of the trace.

VERTICAL ATTENUATOR SWITCH.

Provides ac or dc coupling and signal attenuation. It also grounds the input circuit to provide a zero reference.

VERTICAL INPUT CONNECTORS.

Provide means of applying the vertical signal to the scope.

VERTICAL DC BALANCE CONTROL (On bottom of Oscilloscope)

Minimizes vertical movement of the display when the Vertical Gain Control is adjusted.

1 VOLT PEAK-TO-PEAK CONNECTOR.

A 1 volt peak-to-peak signal is present at this connector. This signal can be used as a comparison to determine the value of an unknown voltage.

Fi

Output amplifiers Q9 and Q10 again amplify the differential signal and drive the vertical plates of the CRT.

SWEEP GENERATOR

The Sync switch selects either a portion of the amplified vertical input signal or a signal applied to the External Sync connector. The selected signal is then coupled to the gate of source follower Q101. (D102 and D103, transistors operated as diodes, protect transistor Q101 from high voltages by zenering at ±9 volts.) Constant current source Q102 is adjusted by the Sync Level control R103 to provide proper biasing of the sync circuits. This insures that even a small signal can sync the sweep generator.

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HORIZONTAL AMPLIFIER

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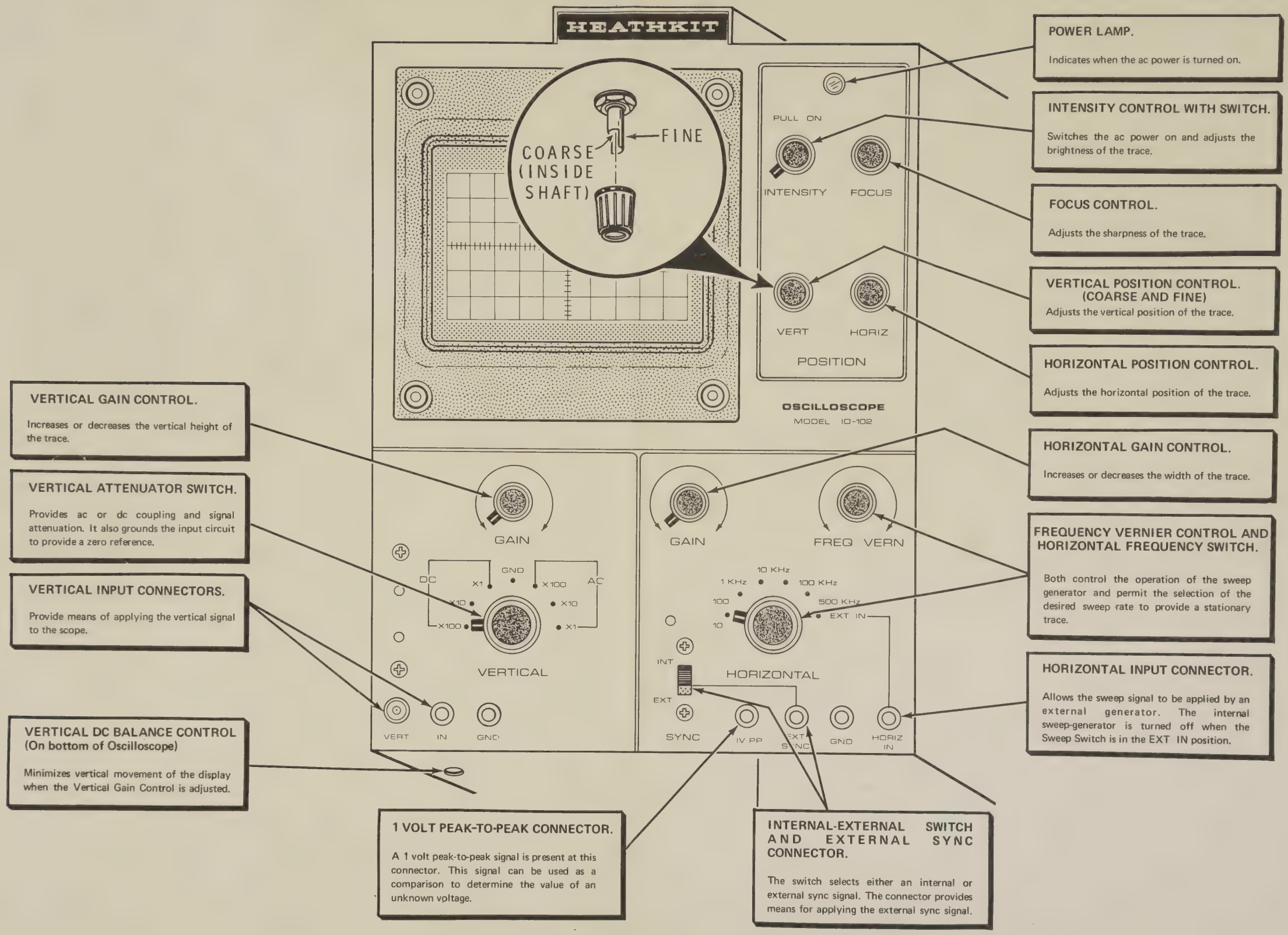
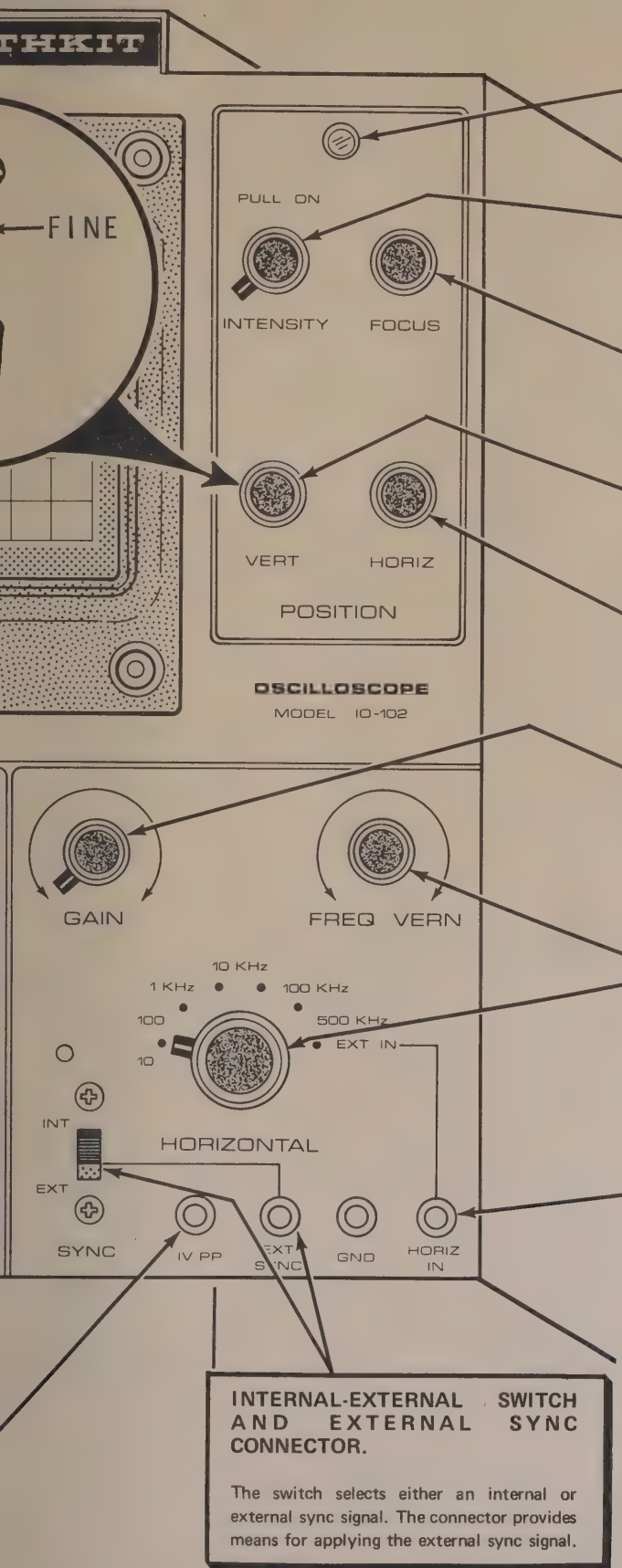

HEATHKIT
COARSE (INSIDE SHAFT)
FINE
PULL ON
INTENSITY
FOCUS
VERT
HORIZ
POSITION
OSCILLOSCOPE
MODEL IO-102
GAIN
GND
DC
AC
X1
X100
X10
VERTICAL
VERT IN
GND
GAIN
FREQ VERN
10 KHz
1 KHz
100 KHz
100
10
500 KHz
EXT IN
INT
EXT
HORIZONTAL
SYNC
IV PP
EXT SYNC
GND
HORIZ IN
POWER LAMP.
Indicates when the ac power is turned on.
INTENSITY CONTROL WITH SWITCH.
Switches the ac power on and adjusts the brightness of the trace.
FOCUS CONTROL.
Adjusts the sharpness of the trace.
VERTICAL POSITION CONTROL. (COARSE AND FINE)
Adjusts the vertical position of the trace.
HORIZONTAL POSITION CONTROL.
Adjusts the horizontal position of the trace.
HORIZONTAL GAIN CONTROL.
Increases or decreases the width of the trace.
FREQUENCY VERNIER CONTROL AND HORIZONTAL FREQUENCY SWITCH.
Both control the operation of the sweep generator and permit the selection of the desired sweep rate to provide a stationary trace.
HORIZONTAL INPUT CONNECTOR.
Allows the sweep signal to be applied by an external generator. The internal sweep-generator is turned off when the Sweep Switch is in the EXT IN position.
VERTICAL GAIN CONTROL.
Increases or decreases the vertical height of the trace.
VERTICAL ATTENUATOR SWITCH.
Provides ac or dc coupling and signal attenuation. It also grounds the input circuit to provide a zero reference.
VERTICAL INPUT CONNECTORS.
Provide means of applying the vertical signal to the scope.
VERTICAL DC BALANCE CONTROL (On bottom of Oscilloscope)
Minimizes vertical movement of the display when the Vertical Gain Control is adjusted.
1 VOLT PEAK-TO-PEAK CONNECTOR.
A 1 volt peak-to-peak signal is present at this connector. This signal can be used as a comparison to determine the value of an unknown voltage.
INTERNAL-EXTERNAL SWITCH AND EXTERNAL SYNC CONNECTOR.
The switch selects either an internal or external sync signal. The connector provides means for applying the external sync signal.

Figure 1



POWER LAMP.

Indicates when the ac power is turned on.

INTENSITY CONTROL WITH SWITCH.

Switches the ac power on and adjusts the brightness of the trace.

FOCUS CONTROL.

Adjusts the sharpness of the trace.

VERTICAL POSITION CONTROL. (COARSE AND FINE)

Adjusts the vertical position of the trace.

HORIZONTAL POSITION CONTROL.

Adjusts the horizontal position of the trace.

HORIZONTAL GAIN CONTROL.

Increases or decreases the width of the trace.

FREQUENCY VERNIER CONTROL AND HORIZONTAL FREQUENCY SWITCH.

Both control the operation of the sweep generator and permit the selection of the desired sweep rate to provide a stationary trace.

HORIZONTAL INPUT CONNECTOR.

Allows the sweep signal to be applied by an external generator. The internal sweep-generator is turned off when the Sweep Switch is in the EXT IN position.

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gure 1

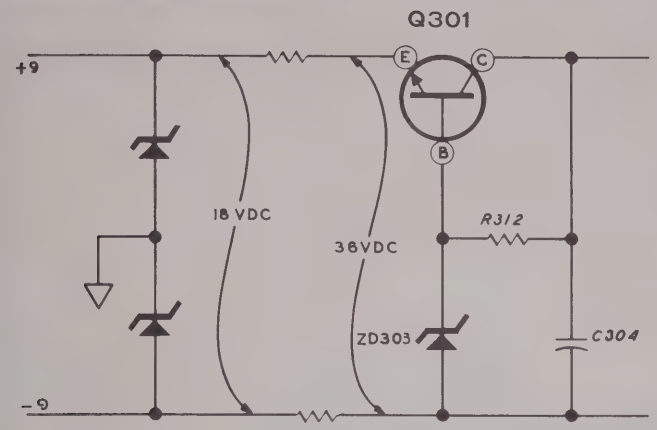
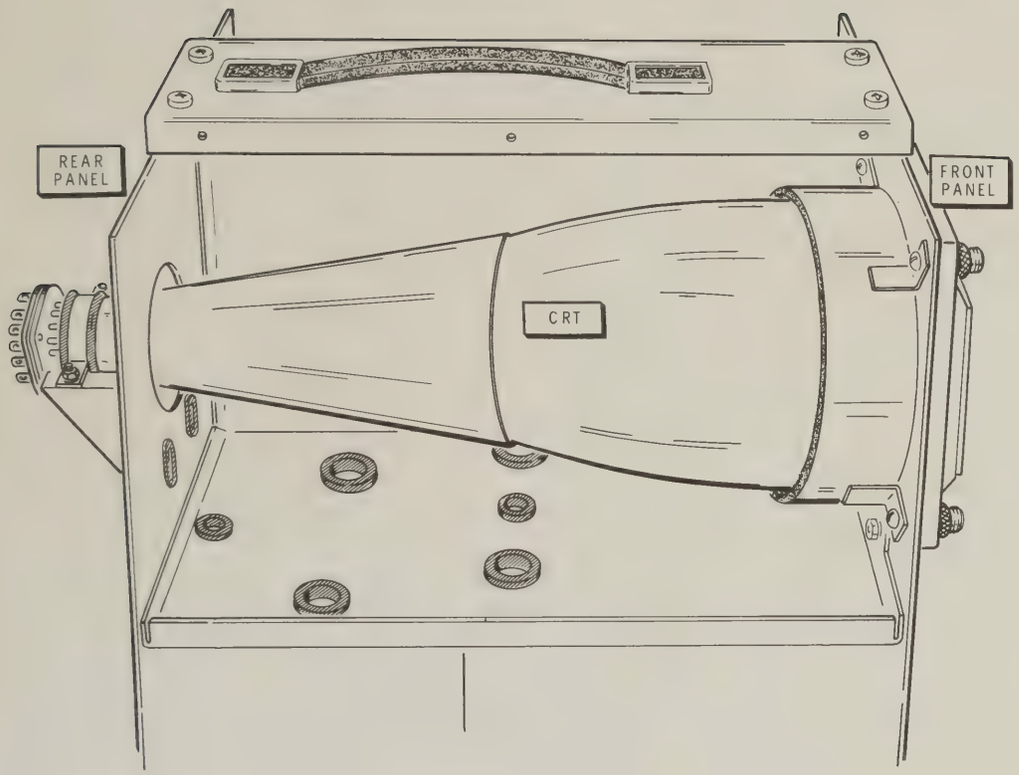


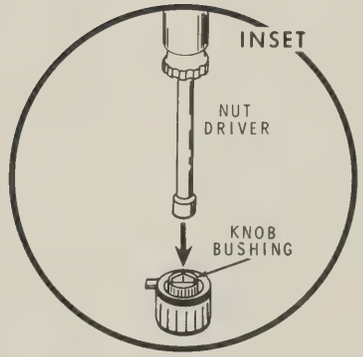
Figure 19

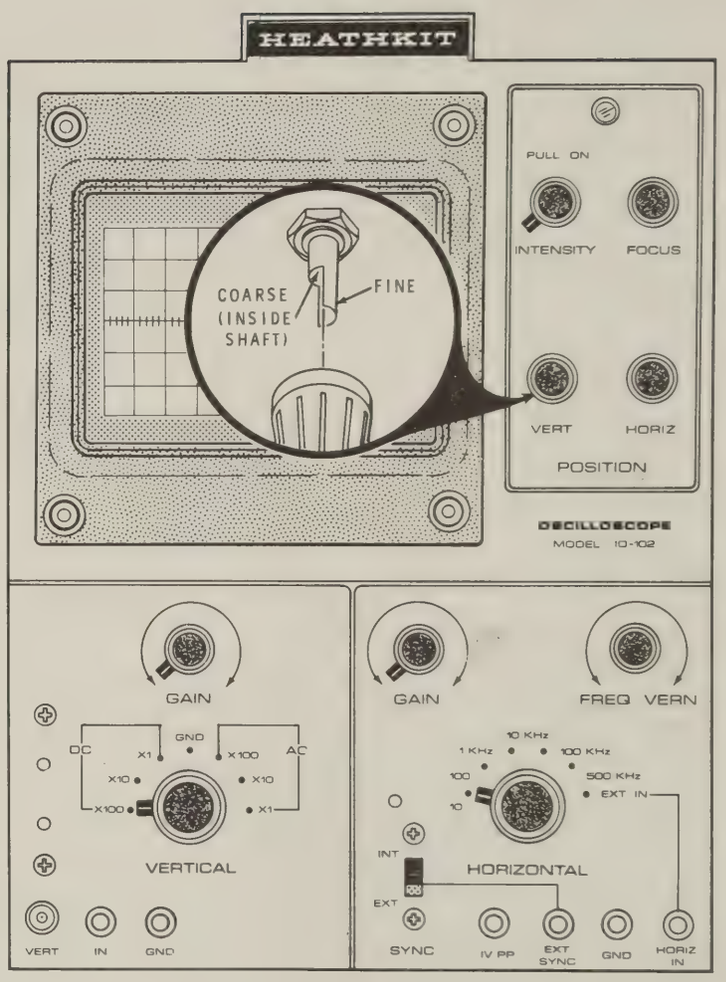
Another secondary winding is connected to the full-wave rectifier circuit consisting of diodes D312, D313, D314, and D315. Capacitor C305 filters the rectified voltage. Zener diodes ZD310, ZD311, and resistor R315 provide a regulated +150 volt dc output. Zener diodes ZD308, ZD309, and resistor R314 provide a regulated +180-volt dc output. Resistor R313 and zener diode ZD101 (located on the sweep generator circuit board) reduces the 180 volts to a regulated +120-volts dc.

A separate secondary winding supplies a 1-volt peak-to-peak voltage to the front panel output jack.

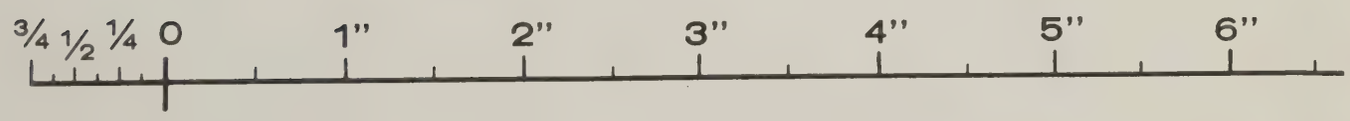


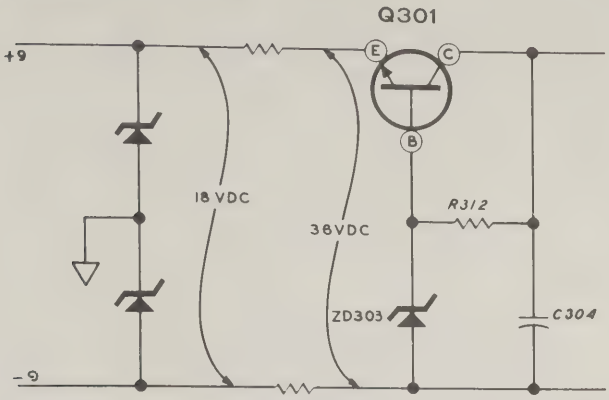
PICTORIAL 5-14





PICTORIAL 5-15





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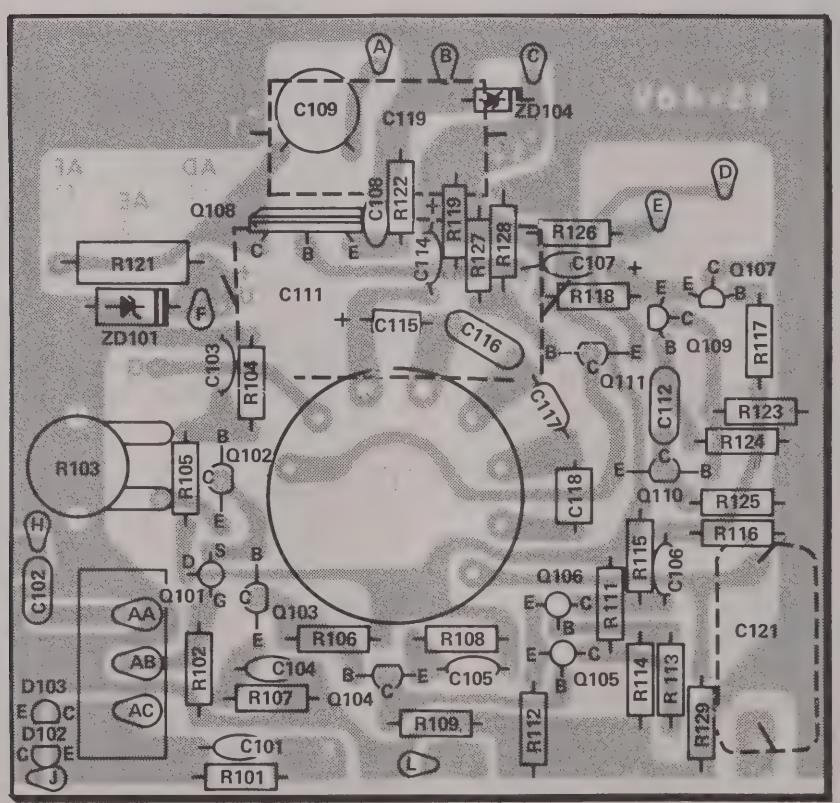
A separate secondary winding supplies a 1-volt peak-to-peak voltage to the front panel output jack.

X-RAY VIEWS

NOTE: To determine the value (22 kΩ, .05 μF, etc.) of one of these parts, you may proceed in either of the following ways.

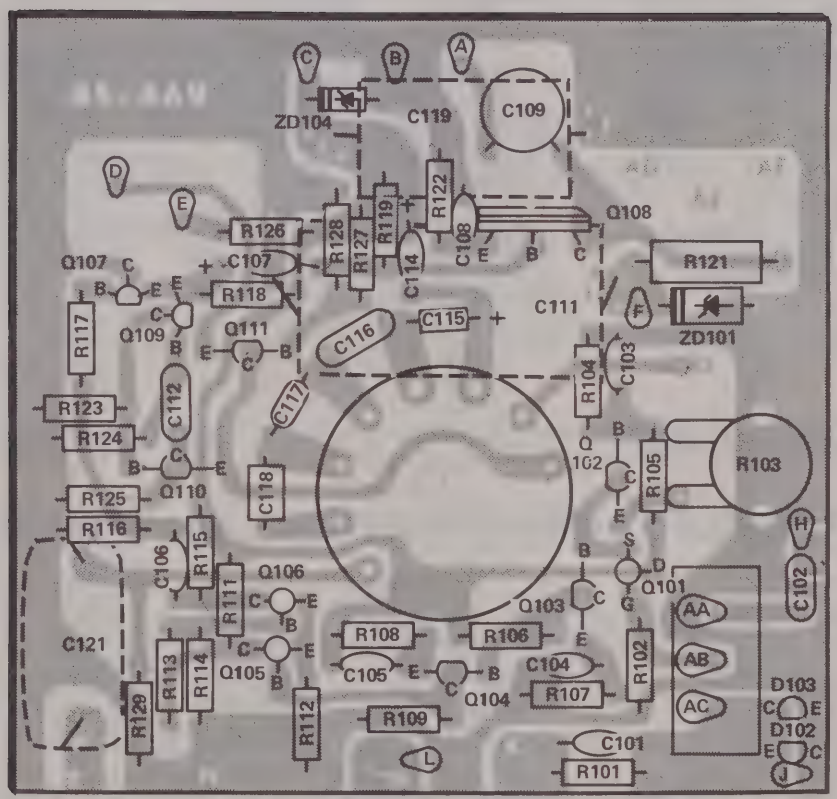
1. Refer to the place where the part is installed in the Step-by-Step instructions.

2. Note the identification number of the part (R-number, C-number, etc.). Then locate the same identification number next to the part on the Schematic. The value, or "Description", of most parts will be near this number. For diodes and transistors, refer to the transistor-diode identification chart.



SWEEP CIRCUIT BOARD
(Viewed from component side)

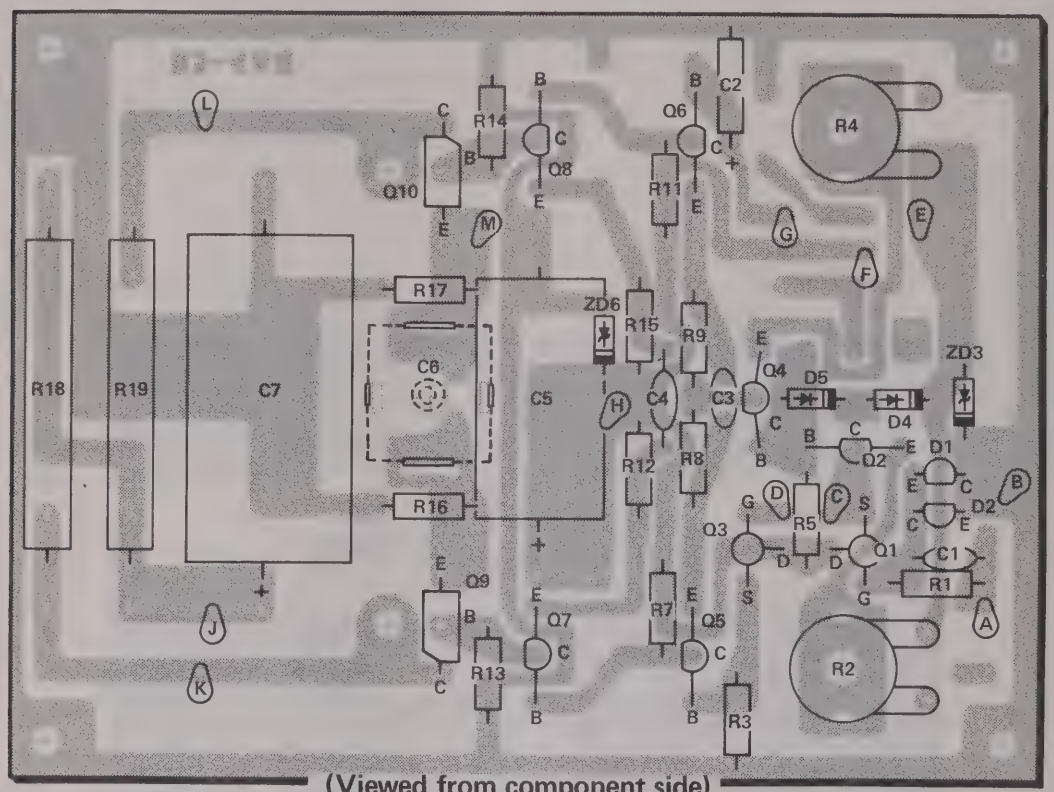
The dotted components are mounted on the foil side of the circuit board.



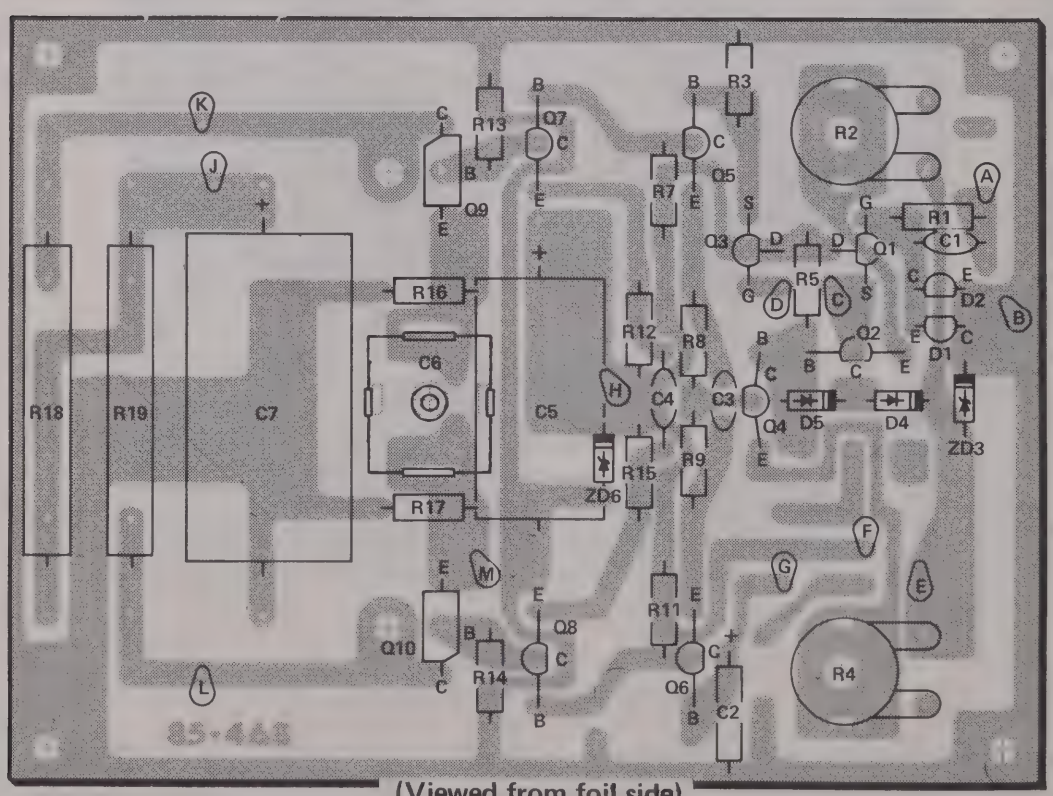
SWEEP CIRCUIT BOARD
(Viewed from foil side)

The dotted components are mounted on the foil side of circuit board.

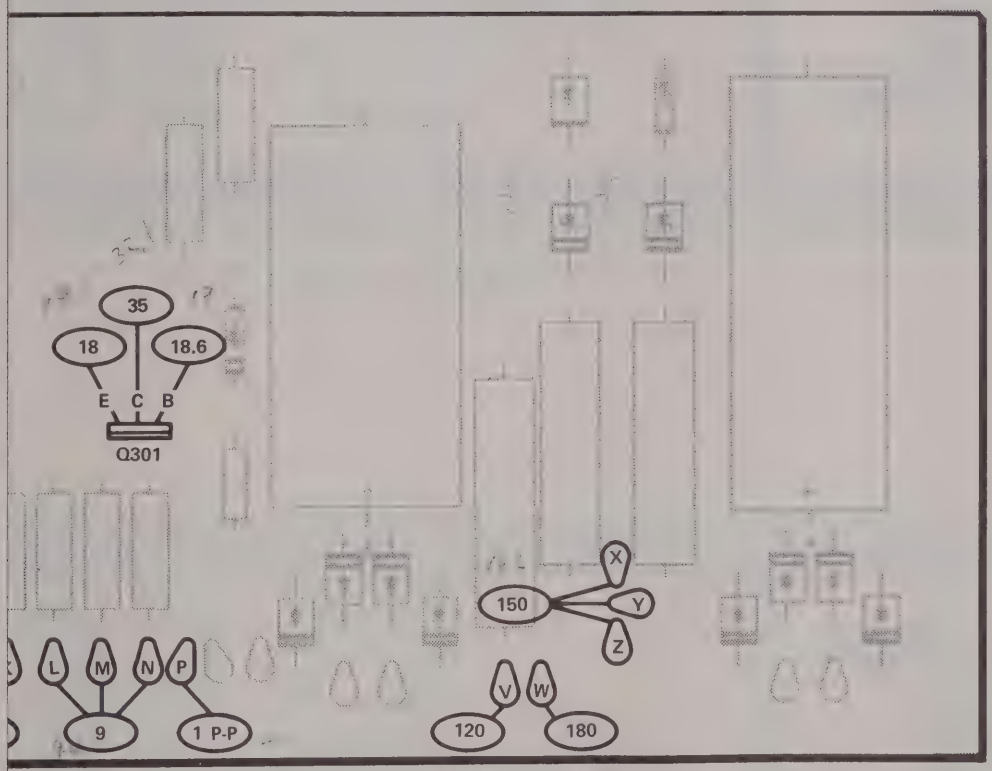
VERTICAL AMPLIFIER CIRCUIT BOARD



(Viewed from component side)



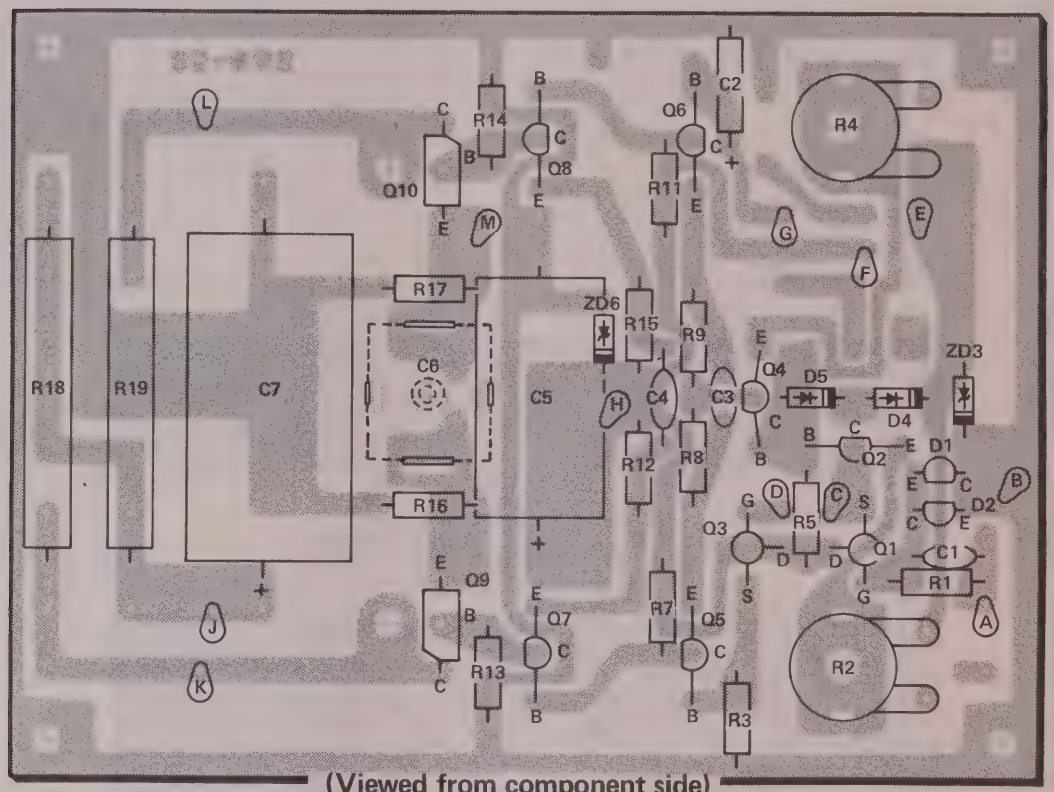
(Viewed from foil side)



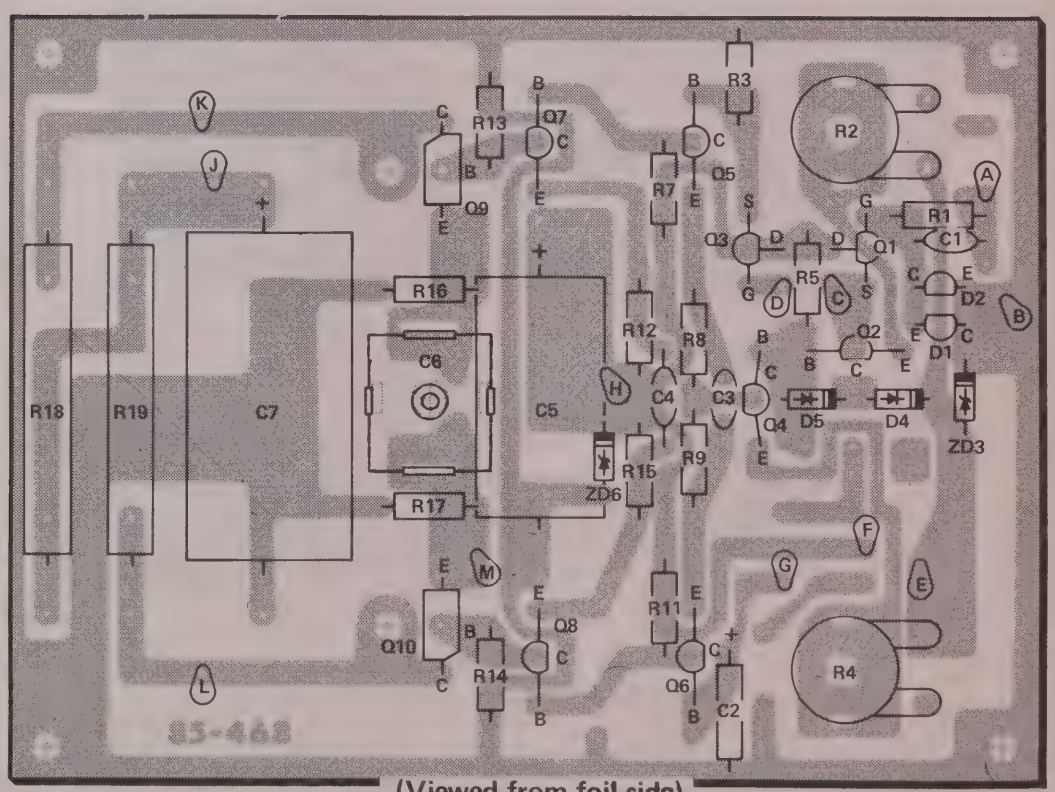
SUPPLY CIRCUIT BOARD
ved from component side)

natic notes for voltage conditions.

VERTICAL AMPLIFIER CIRCUIT BOARD

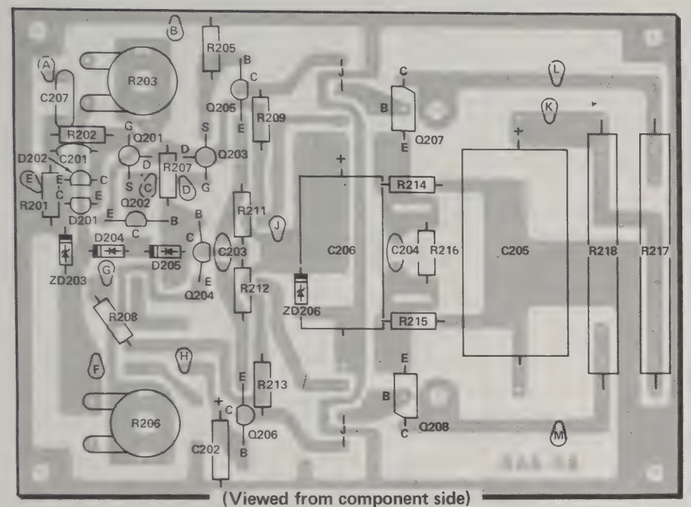


(Viewed from component side)

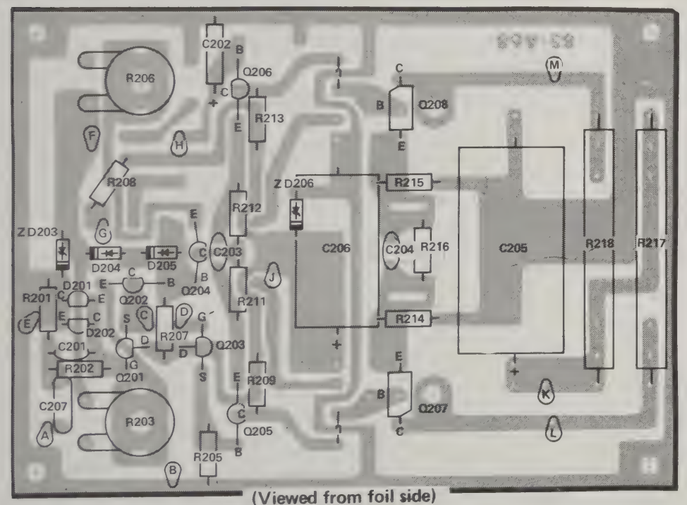


(Viewed from foil side)

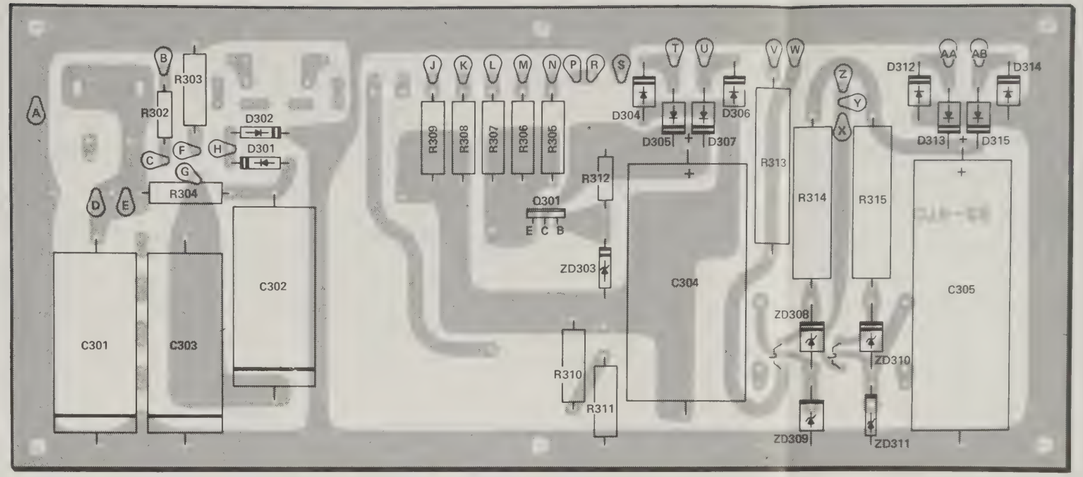
HORIZONTAL AMPLIFIER CIRCUIT BOARD



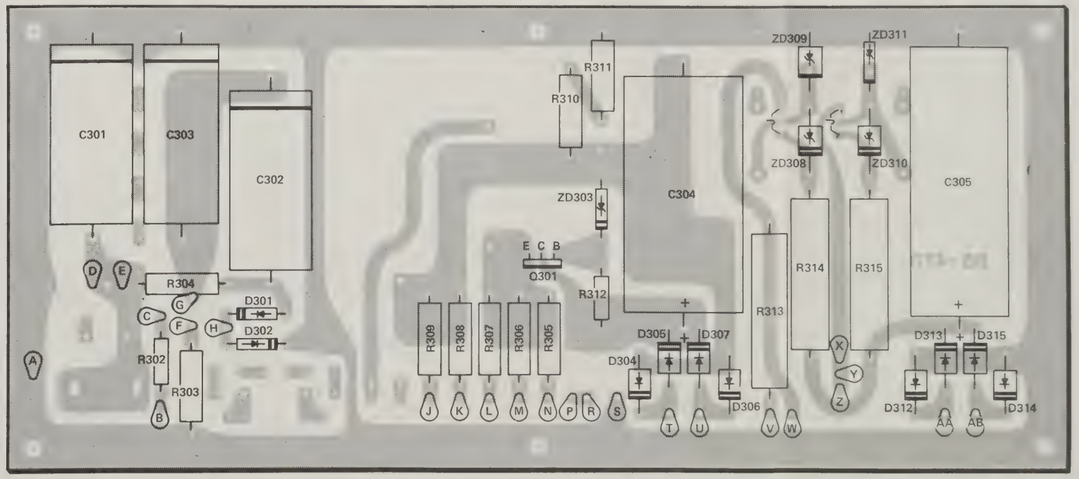
(Viewed from component side)



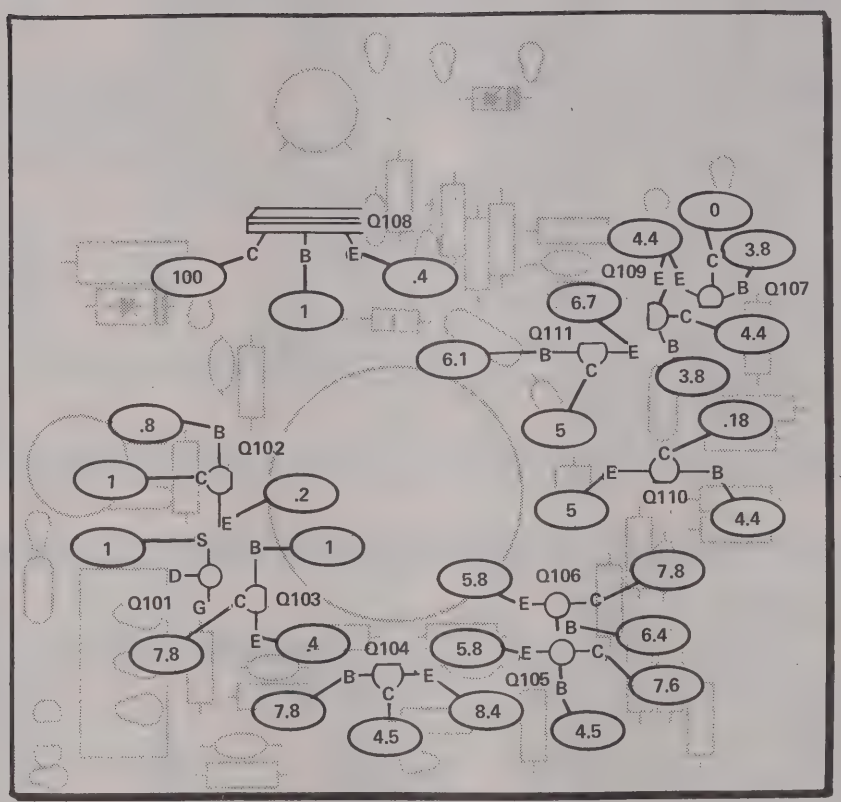
(Viewed from foil side)



POWER SUPPLY CIRCUIT BOARD
(Viewed from foil side)

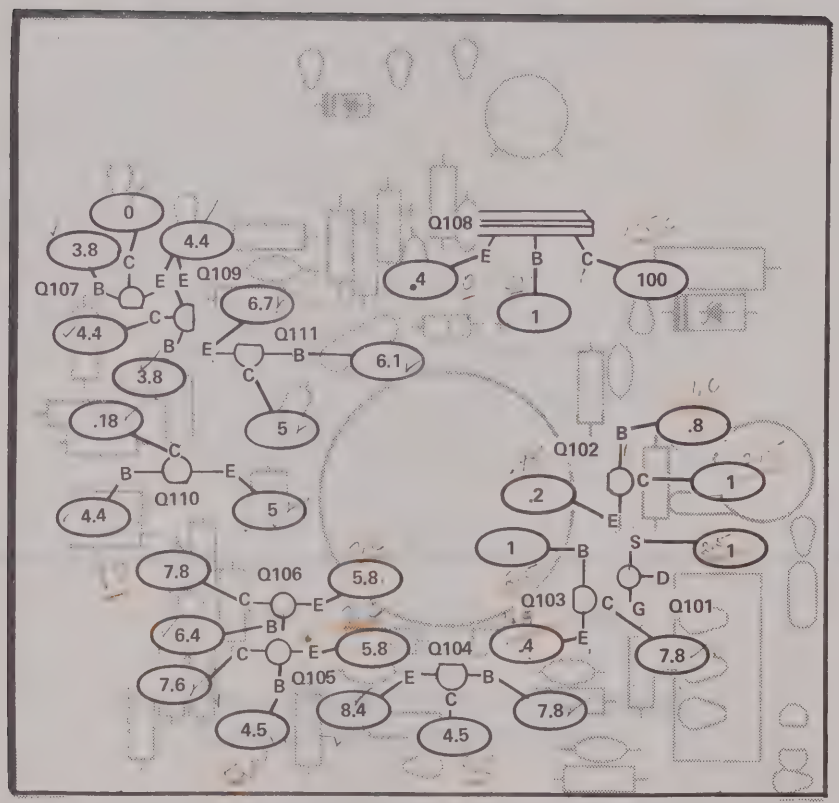


POWER SUPPLY CIRCUIT BOARD
(Viewed from component side)



SWEEP CIRCUIT BOARD
(Viewed from component side)

See the Schematic notes for voltage conditions.



SWEEP CIRCUIT BOARD
(Viewed from foil side)

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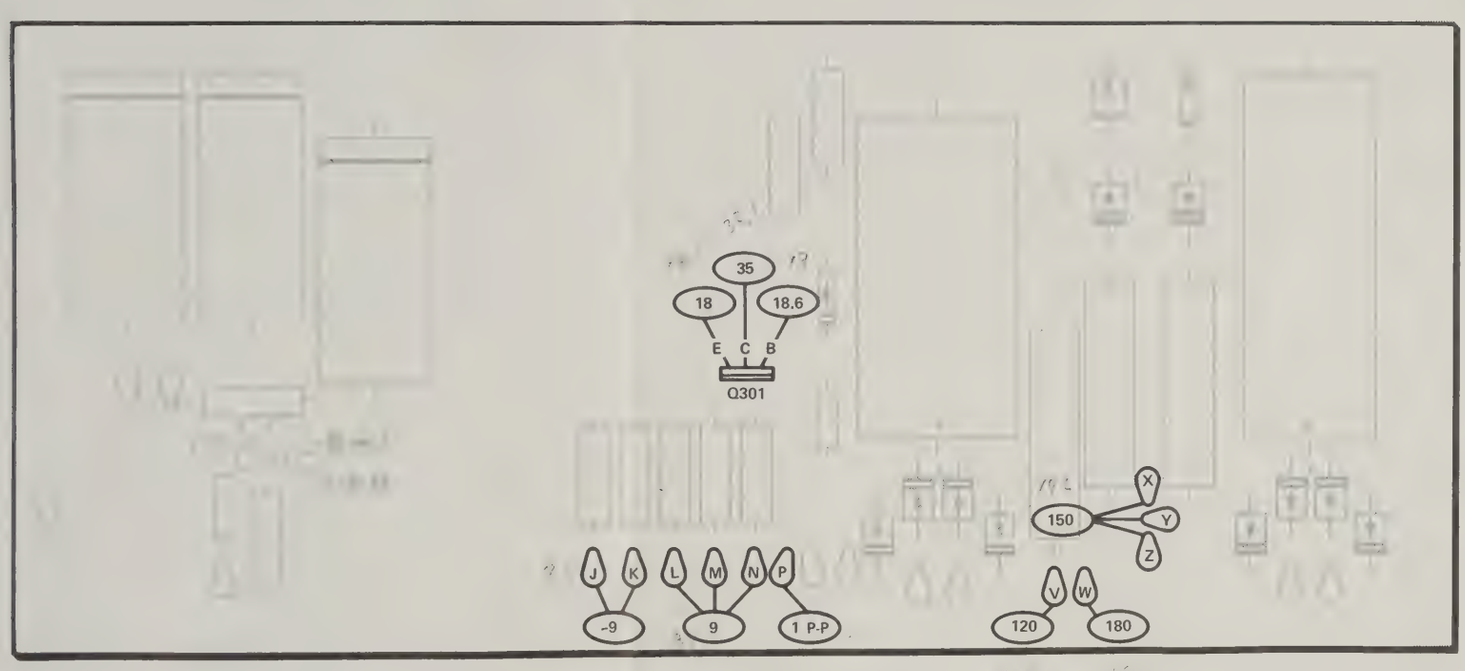
VOLTAGE CHARTS



POWER SUPPLY CIRCUIT BOARD
(Viewed from component side)

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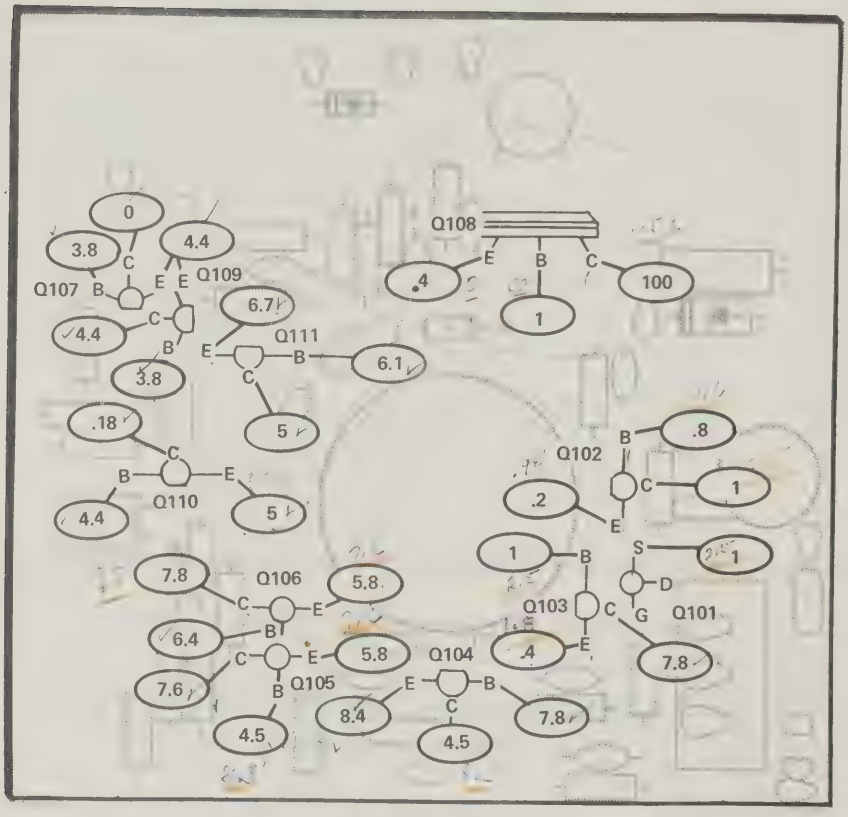

SWEEP CIRCUIT BOARD
(Viewed from foil side)

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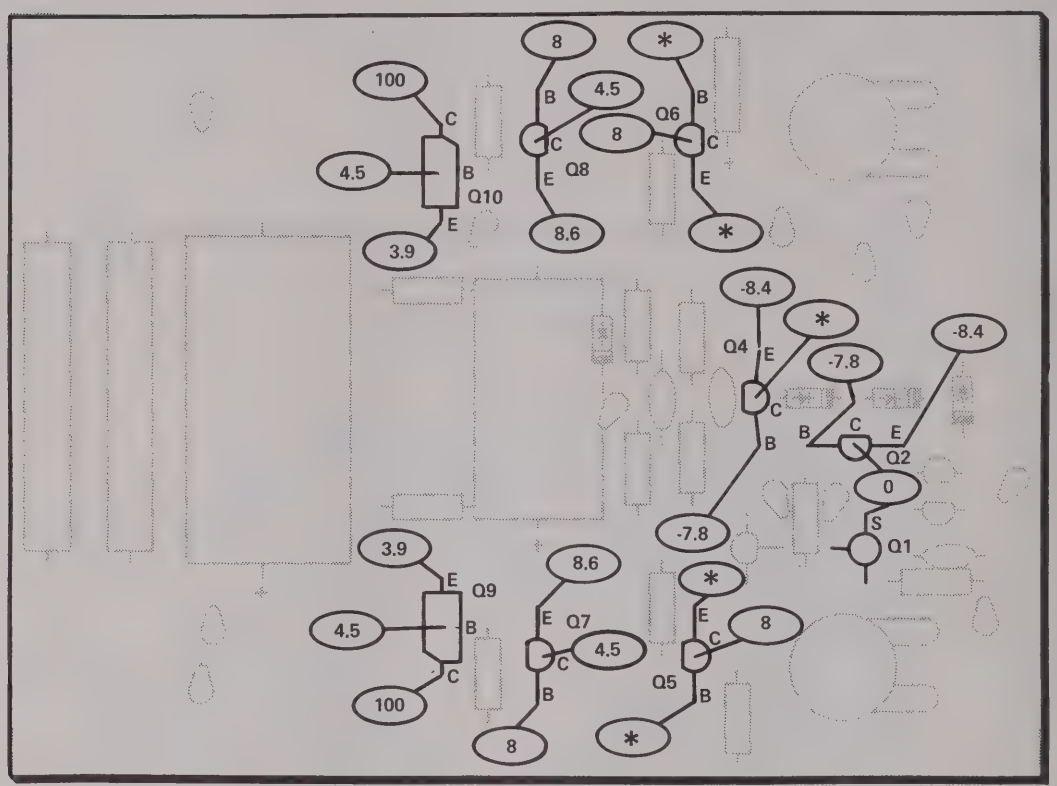
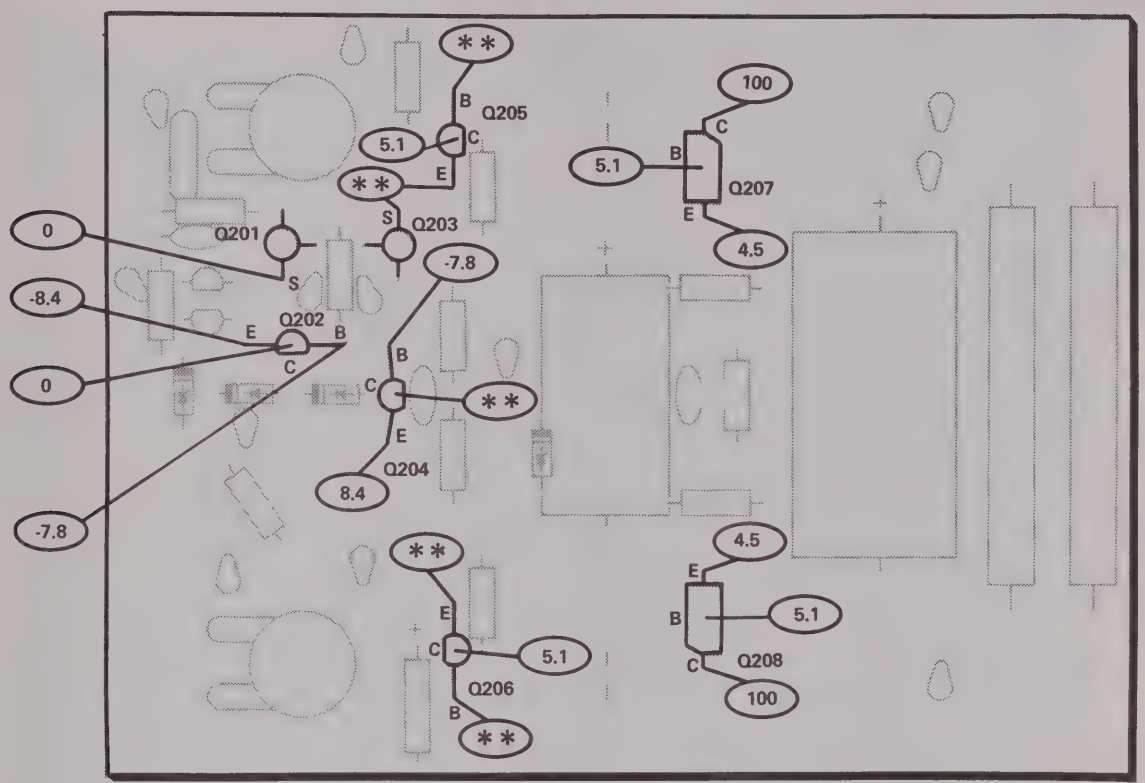


* This voltage depends on operating parameters of transistor Q3.

VERTICAL AMPLIFIER CIRCUIT BOARD
(Viewed from component side)

See the Schematic notes for voltage conditions.

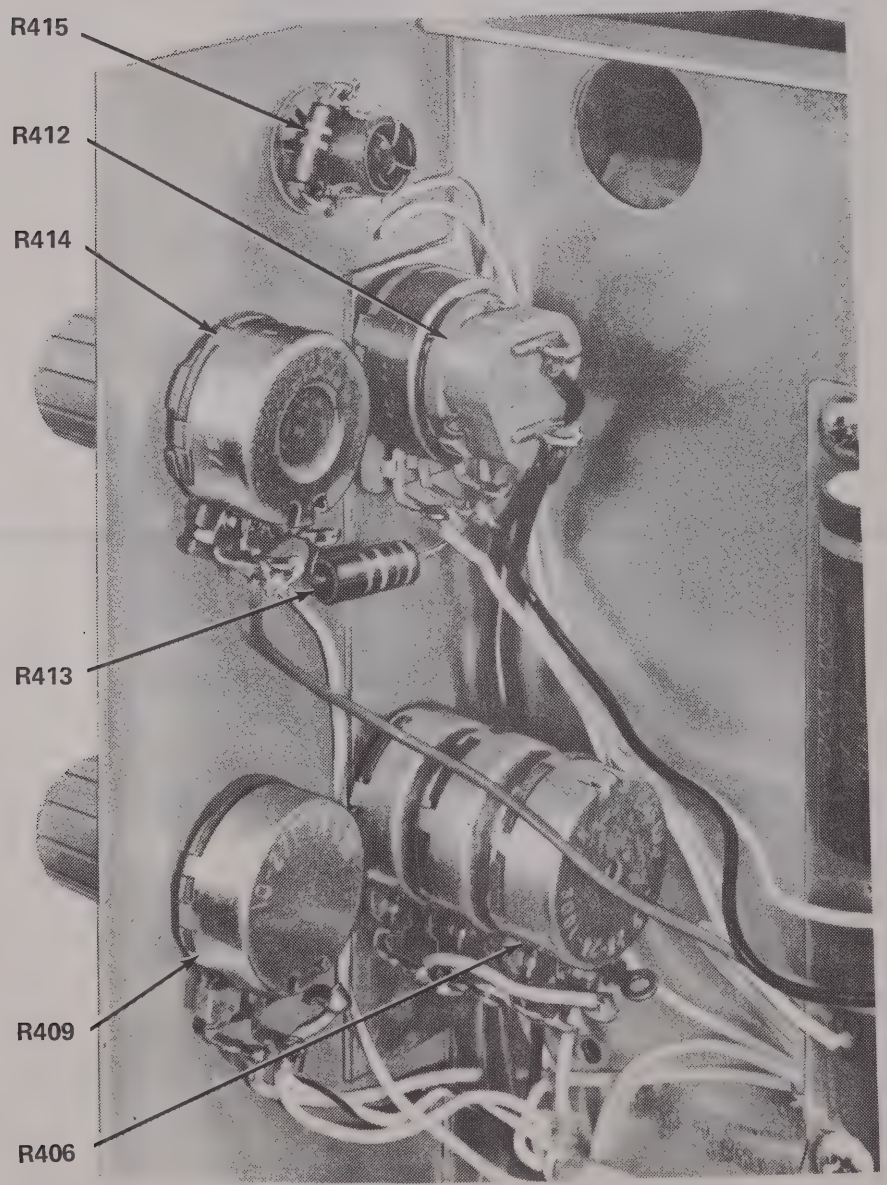


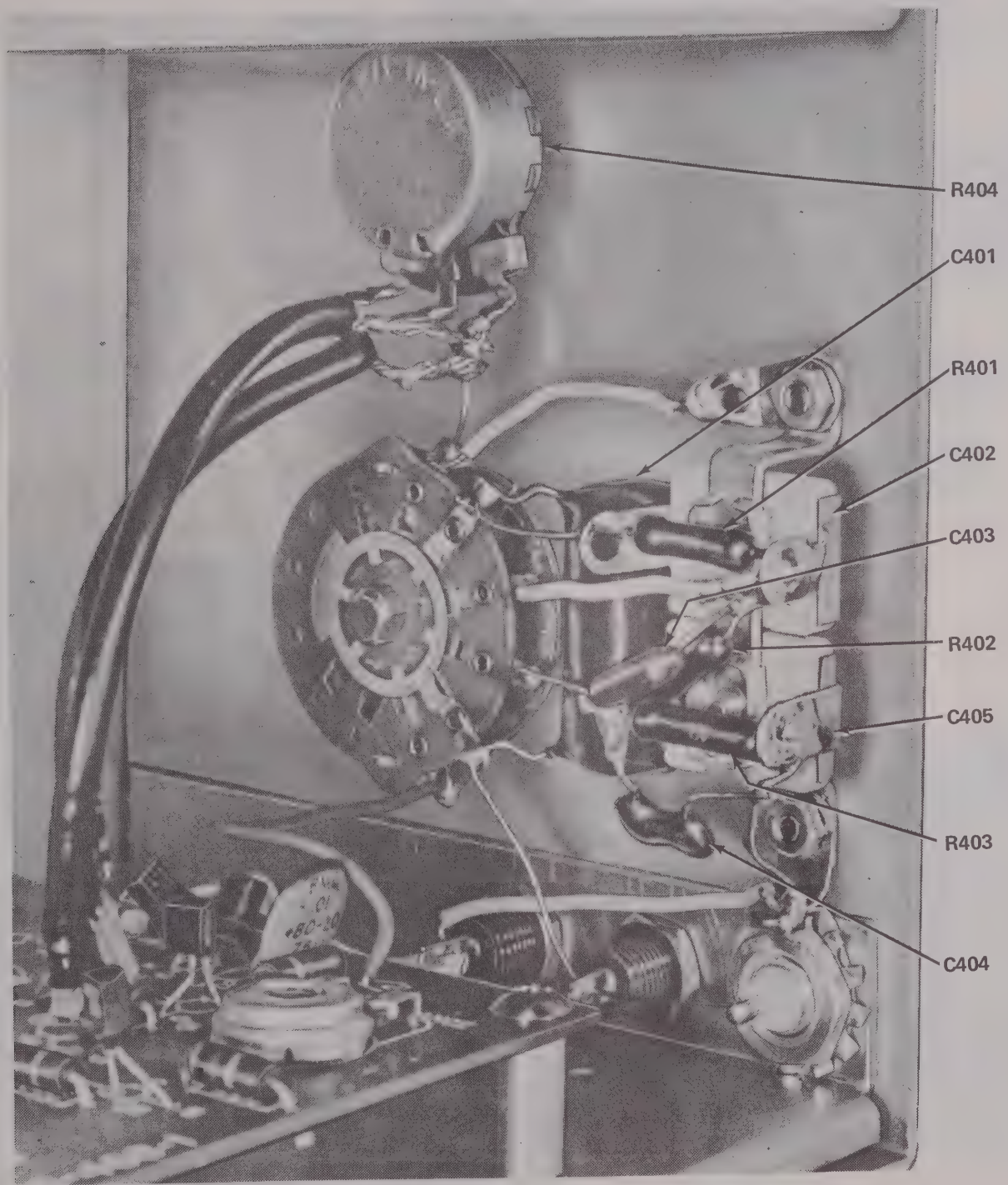
** This voltage depends on operating parameters of transistor Q204.

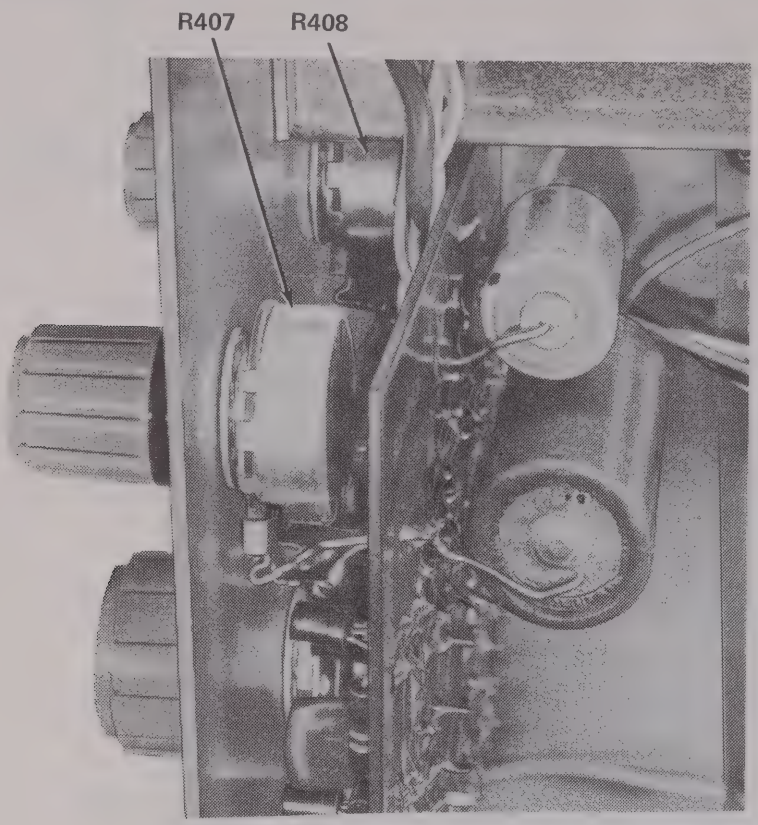
HORIZONTAL AMPLIFIER CIRCUIT BOARD
(Viewed from component side)

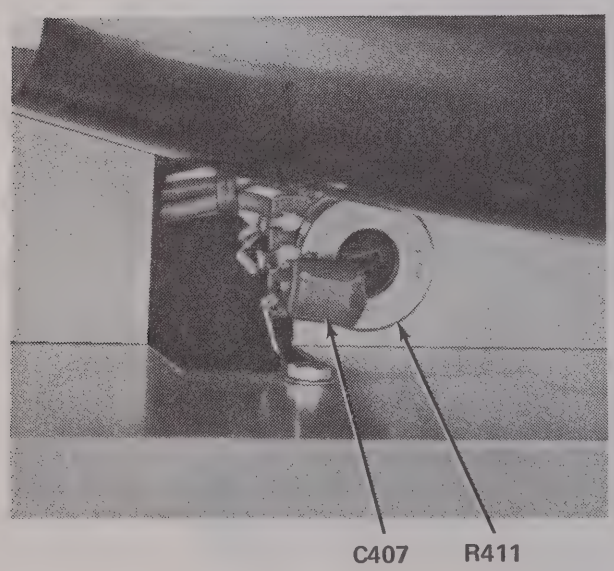
See the Schematic notes for voltage conditions.

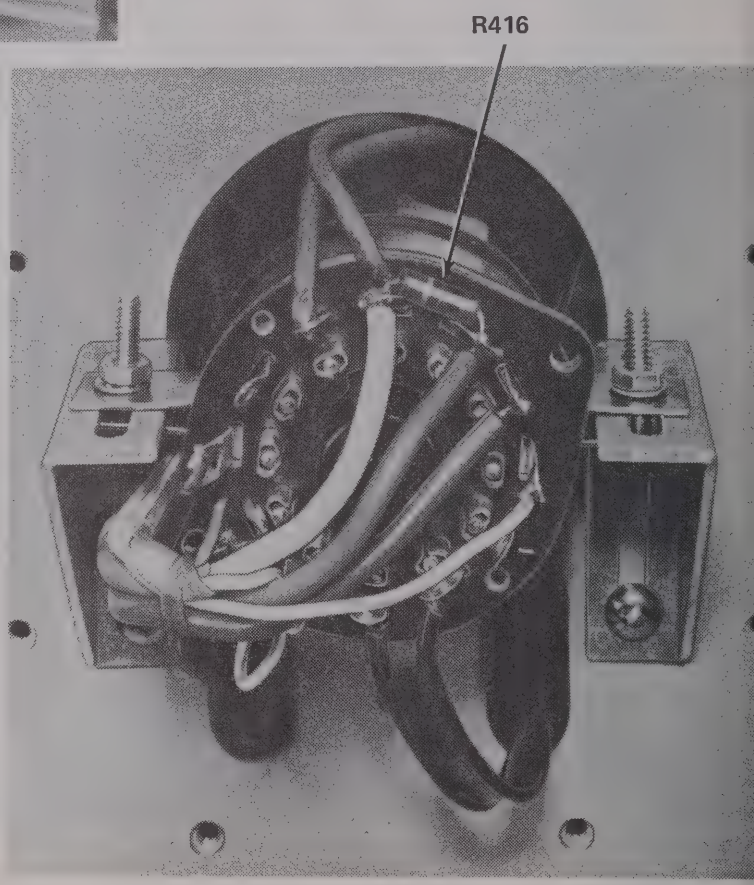
CHASSIS PHOTOGRAPHS




R404
C401
R401
C402
C403
R402
C405
R403
C404


R407
R408


C407
R411


R416

REPLACEMENT PARTS PRICE LIST

The following prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties and rates of exchange.

To order parts, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to Replacement Parts in the Kit Builders Guide.

POWER SUPPLY CIRCUIT BOARD

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/2-Watt, 10%		
1-9	.10	1000 Ω
1-35	.10	1 MΩ
1-Watt, 10%		
1-19-1	.10	220 Ω
1-32-1	.10	470 kΩ
1-37-1	.10	3.3 MΩ
7-Watt, 10%		
3-14-7	.15	2000 Ω (2 kΩ)
3-2-7	.20	3750 Ω
3-21-7	.15	4700 Ω (4.7 kΩ)
CAPACITORS		
23-62	.75	.1 μF, 1600 V
25-43	1.15	70 μF, 350 V, electrolytic
25-121	1.30	500 μF, 50 V, electrolytic
DIODES		
56-48	3.15	110 V, 15 mA, zener
56-55	1.00	36 V, 4 mA, zener
56-66	.90	43 V, 6 mA, zener
56-68	1.50	68 V, 7 mA, zener
57-27	.50	1N2071, silicon
57-52	1.20	2 kV, 5 mA, silicon
TRANSISTOR		
417-175	1.45	TA2911 transistor
MISCELLANEOUS		
344-50	.05/ft	Black wire
344-52	.05/ft	Red wire
344-59	.05/ft	White wire
331-6	.15	Solder
PARTS FROM PACK #5		
85-470-3	2.05	Power supply circuit board
	2.00	Manual (See front cover for part number.)

VERTICAL AMPLIFIER CIRCUIT BOARD

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/2-Watt, 10%		
1-3	.10	100 Ω
1-4	.10	330 Ω
1-9	.10	1000 Ω
1-20	.10	10 kΩ
1-35	.10	1 MΩ
4-Watt, 10%		
5-1-4	.20	5600 Ω (5.6 k)
CAPACITORS		
Electrolytic		
25-54	.20	10 μF, 15 V
25-20	.60	40 μF, 150 V
25-111	2.35	1000 μF, 15 V
Disc		
21-11	.10	150 pF
21-56	.10	470 pF
21-16	.10	.01 μF
Other Capacitor		
31-49	.85	250-1000 pF trimmer
DIODES		
56-19	1.00	9.1 V, 25 mA, zener
56-56	.20	1N4149, silicon
TRANSISTORS		
417-83	.75	L842
417-118	.40	2N3393
417-201	.50	X29A829
417-169	1.50	MPF105
417-245	.95	D40N1
HARDWARE		
250-229	.05	6-32 x 1/4" screw
254-1	.05	#6 lockwasher
255-94	.10	1/2" threaded spacer
MISCELLANEOUS		
10-381	.35	500 Ω control
10-397	.35	200 Ω control
343-7	.05/ft	Coaxial cable
347-2	.15/ft	Twin lead
PART FROM PACK #5		
85-468-1	1.65	Vertical amplifier circuit board

HORIZONTAL AMPLIFIER CIRCUIT BOARD

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/2-Watt, 10%		
1-3	.10	100 Ω
1-6	.10	470 Ω
1-9	.10	1000 Ω
1-20	.10	10 kΩ
1-35	.10	1 MΩ
1-40	.10	10 MΩ
7-Watt, 5%		
5-3-7	.25	10 kΩ
CAPACITORS		
Electrolytic		
25-54	.20	10 μF, 15 V
25-71	.75	30 μF, 200 V
25-111	2.35	1000 μF, 15 V
Disc		
21-56	.10	470 pF
21-16	.10	.01 μF
Mylar		
27-77	.10	.1 μF
DIODES		
56-19	1.00	9.1 V, 25 mA, zener
56-56	.20	1N4149 silicon
TRANSISTORS		
417-118	.40	2N3393
417-169	1.50	MPF105
417-245	.95	D40N1
HARDWARE		
250-229	.05	6-32 x 1/4" screw
254-1	.05	#6 lockwasher
255-94	.10	1/2" threaded spacer
MISCELLANEOUS		
10-381	.35	500 Ω control
PART FROM PACK #5		
85-468-2	1.65	Horizontal amplifier circuit board

SWEEP CIRCUIT BOARD

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/2-Watt, 10%		
1-3	.10	100 Ω
1-42	.10	270 Ω
1-6	.10	470 Ω
1-9	.10	1000 Ω
1-16	.10	4700 Ω
1-26	.10	100 kΩ
1-35	.10	1 MΩ
1-Watt, 10%		
1-24-1	.10	4700 Ω
CAPACITORS		
Disc		
21-56	.10	470 pF
21-141	.10	.0033 μF
21-16	.10	.01 μF
21-42	.15	.01 μF, 1.6 kV
Mica		
20-100	.15	30 pF
Mylar		
27-74	.10	.01 μF
27-77	.10	.1 μF, 100 V
27-112	.25	.1 μF, 600 V
Polystyrene		
29-5	.10	1000 pF
Electrolytic		
25-197	.70	1 μF tantalum
25-220	.45	10 μF tantalum
25-20	.60	40 μF, 150 V
25-111	2.35	1000 μF, 15 V
DIODES		
56-19	1.00	9.1 V, 25 mA, zener
56-48	3.15	10 V, 15 mA, zener
TRANSISTORS		
417-83	.75	L842
417-118	.40	2N3393
417-201	.50	X29A829
417-221	.45	TZ582
417-169	1.50	MPF105
417-154	1.65	2N2369A
417-245	.95	D40N1
MISCELLANEOUS		
10-381	.35	500 Ω control
10-258	.50	10 kΩ control
60-4	.20	Slide switch
74-4	.25	Tape
PARTS FROM PACK #5		
63-589	1.50	Rotary switch
85-469-1	1.20	Sweep circuit board

CHASSIS

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/2-Watt, 10%		
1-26	.10	100 kΩ
1-35	.10	1 MΩ
1/2-Watt, 1%		
2-50	.20	10 kΩ
2-41	.20	90 kΩ
2-51	.20	900 kΩ
1-Watt, 10%		
1-32-1	.10	470 kΩ
CAPACITORS		
Mica		
20-100	.15	30 pF
20-113	.30	470 pF
Mylar		
27-77	.10	.1 μF, 100 V
27-112	.25	.1 μF, 600 V
Other Capacitor		
31-18	.50	Dual trimmer
CONTROLS		
10-271	.65	1000 Ω
10-224	.60	1 MΩ
10-282	.35	150 kΩ
13-9	2.45	Triple control
19-149	1.15	250 kΩ
INSULATORS		
70-5	.10	Black insulator
70-6	.10	Red insulator
73-2	.10	Large rubber grommet
73-3	.10	Small rubber grommet
73-5	.10	Cushion strip
75-71	.10	Line cord strain relief
METAL PARTS		
90-513-1	3.75	Cabinet shell
100-296	1.00	CRT ring
100-1046	2.70	Transformer side shield
200-598	2.60	Chassis
203-770-1	2.65	Front panel
203-771-1	2.35	Rear panel
204-1169	1.00	Circuit board mounting plate
204-1170	.35	CRT mounting bracket
204-1171-1	1.30	Top bracket
206-304	4.50	Tube shield
206-518	.50	Transformer top shield
207-1	.10	CRT clamp

TERMINAL STRIP-CONNECTOR-SOCKET

PART No.	PRICE Each	DESCRIPTION
431-42	.10	5-lug terminal strip
431-82	.10	Terminal collar
432-59	1.65	BNC connector (with hardware)
434-41	.30	Tube socket

JACKS-PLUGS

PART No.	PRICE Each	DESCRIPTION
436-11	.15	Red banana jack (with nut)
436-22	.15	Black banana jack (with nut)
438-13	.15	Banana plug

INSERTS-KNOBS

PART No.	PRICE Each	DESCRIPTION
455-50	.10	Knob insert
462-245	.25	Large knob
462-248	.60	Small knob with pointer
462-249	.40	Small knob

HARDWARE

#6 Hardware

PART No.	PRICE Each	DESCRIPTION
250-229	.05	6-32 x 1/4" screw
250-89	.05	6-32 x 3/8" screw
250-26	.05	6-32 x 5/8" screw
252-3	.05	6-32 nut
254-1	.05	#6 lockwasher
255-94	.10	1/2" spacer
259-1	.05	#6 solder lug

#8 Hardware

PART No.	PRICE Each	DESCRIPTION
250-137	.05	8-32 x 3/8" screw

#10 Hardware

PART No.	PRICE Each	DESCRIPTION
250-50	.05	10-32 x 3/8" screw
252-5	.05	10-32 nut
254-3	.05	#10 lockwasher

Other Hardware

PART No.	PRICE Each	DESCRIPTION
250-287	.20	3/4" threaded stud
252-7	.05	Control nut
252-73	.05	Speed Nut*
252-86	.10	Thumbnut
253-10	.05	Control flat washer
254-4	.05	Control lockwasher
259-27	.05	Control solder lug

MISCELLANEOUS

PART No.	PRICE Each	DESCRIPTION
54-258	12.70	Power transformer
63-588	1.40	Rotary switch
89-23	.75	Line cord
134-252	3.45	Wiring harness
210-48	1.20	Bezel
211-49	2.15	Handle
214-117	2.20	Plastic housing
260-1	.10	Alligator clip
261-28	.05	Plastic foot
341-1	.10/ft	Black test lead
341-2	.10/ft	Red test lead
390-362	.10	Fuse label
391-54	.15	"Heathkit" nameplate
411-265	23.50	5DEP1F tube
412-15	.20	Neon lamp (NE-2H)
413-10	.10	Plastic lens
414-10	.95	Window
414-22	1.65	Graticule
421-23	.30	1 ampere, slow-blow fuse
422-1	.60	Fuseholder
490-5	.10	Nut starter

*Tinnerman Registered Trademark

SCHEMATIC OF THE HEATHKIT OSCILLOSCOPE MODEL IO-102

IDENTIFICATION CHART

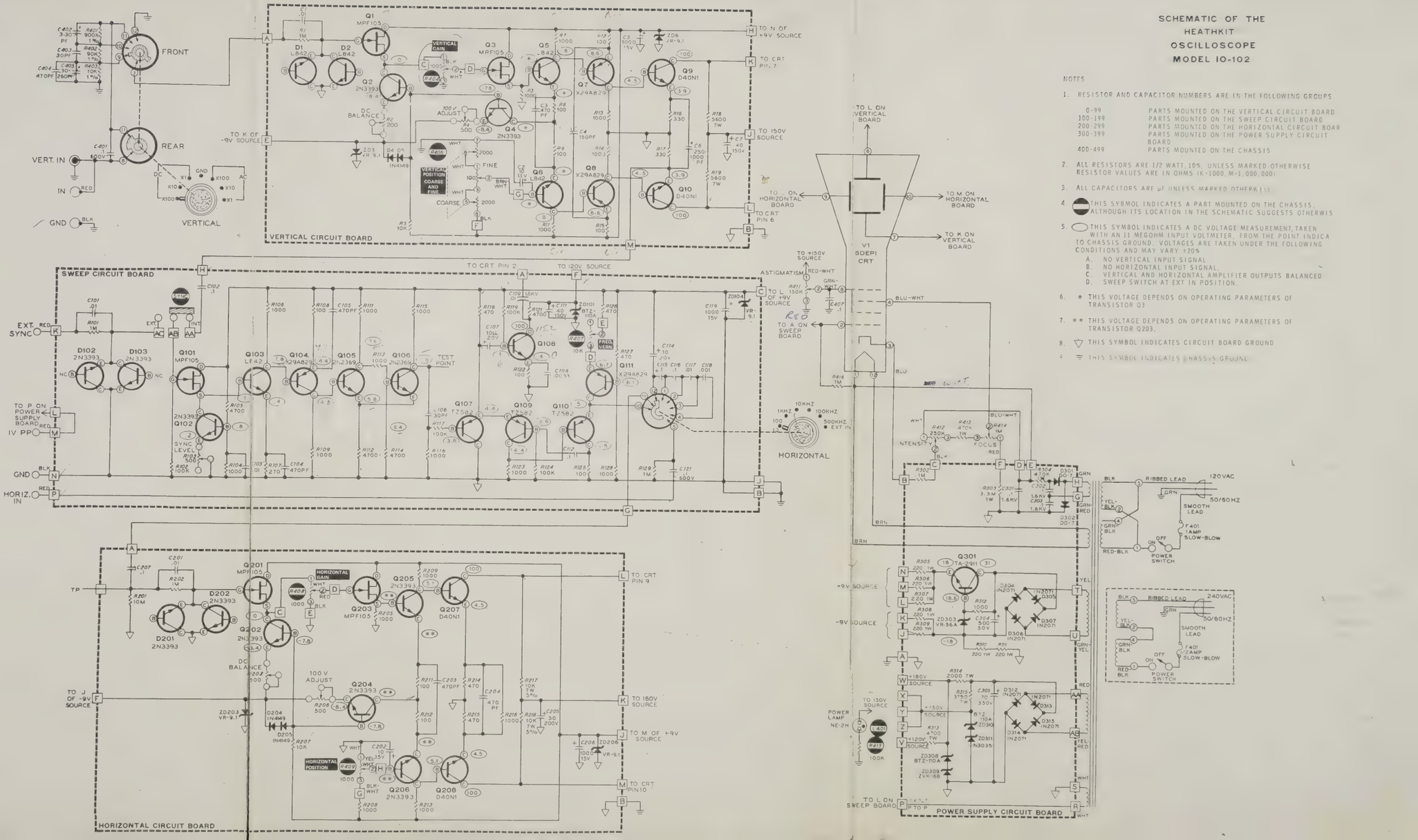
HEATH PART NUMBER	MANUFACTURER'S NUMBER	BASING
417-83 417-118 417-201 417-221	L842 2N3393 X29A829 TZ582	BASE COLLECTOR EMITTER
417-154	2N2369	EMITTER BASE COLLECTOR
417-169	MPF105	GATE DRAIN SOURCE
417-175	2N5294	EMITTER COLLECTOR BASE
417-245	D40N1	COLLECTOR BASE EMITTER
56-19	VR-9.1, 9.1V, 25mA ZENER	
56-48	BZT110A, 110V, 15mA ZENER	
56-55	VR-36A, 36V, 4mA ZENER	
56-56	1N4149	
56-66	1N3035, 43V, 6mA ZENER	
56-68	ZVR-68, 68V, 7mA ZENER	
57-27	1N2071	
57-52	DO-7	

NOTES

1. RESISTOR AND CAPACITOR NUMBERS ARE IN THE FOLLOWING GROUPS

0-99	PARTS MOUNTED ON THE VERTICAL CIRCUIT BOARD
100-199	PARTS MOUNTED ON THE SWEEP CIRCUIT BOARD
200-299	PARTS MOUNTED ON THE HORIZONTAL CIRCUIT BOAR
300-399	PARTS MOUNTED ON THE POWER SUPPLY CIRCUIT BOARD
400-499	PARTS MOUNTED ON THE CHASSIS

2. ALL RESISTORS ARE 1/2 WATT, 10%, UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K=1000, M=1,000,000).
3. ALL CAPACITORS ARE μF UNLESS MARKED OTHERWISE.
4. ⬬ THIS SYMBOL INDICATES A PART MOUNTED ON THE CHASSIS, ALTHOUGH ITS LOCATION IN THE SCHEMATIC SUGGESTS OTHERWIS
5. ⬭ THIS SYMBOL INDICATES A DC VOLTAGE MEASUREMENT, TAKEN WITH AN 11 MEGOHM INPUT VOLTMETER, FROM THE POINT INDICA TO CHASSIS GROUND. VOLTAGES ARE TAKEN UNDER THE FOLLOWING CONDITIONS AND MAY VARY ±20%
   - A. NO VERTICAL INPUT SIGNAL
   - B. NO HORIZONTAL INPUT SIGNAL.
   - C. VERTICAL AND HORIZONTAL AMPLIFIER OUTPUTS BALANCED
   - D. SWEEP SWITCH AT EXT IN POSITION.
6. * THIS VOLTAGE DEPENDS ON OPERATING PARAMETERS OF TRANSISTOR Q3
7. ** THIS VOLTAGE DEPENDS ON OPERATING PARAMETERS OF TRANSISTOR Q203.
8. ▽ THIS SYMBOL INDICATES CIRCUIT BOARD GROUND
9. = THIS SYMBOL INDICATES CHASSIS GROUND



HEATHKIT

HEATH COMPANY

Phone 616-983-3961 • TWX-616-983-3897 • Benton Harbor, Michigan 49022

Dear Heathkit Customer:

The following information replaces any other warranty material that may be supplied with your new Heathkit.

Thank you,

HEATH COMPANY

7-30-71

Dear Customer:

You have just purchased one of the best performing electronic products in the world — your Heathkit.

Here's how we aim to keep it that way:

Your Heathkit Warranty

During your first 90 days of ownership, any parts which we find are defective, either in materials or workmanship, will be replaced or repaired free of charge. And we'll pay shipping charges to get those parts to you — anywhere in the world.

If we determine a defective part has caused your Heathkit to need other repair, through no fault of yours, we will service it free — at the factory, at any retail Heathkit Electronic Center, or through any of our authorized overseas distributors.

This protection is exclusively yours as the original purchaser. Naturally, it doesn't cover damage by use of acid-core solder, incorrect assembly, misuse, fire, flood or acts of God. But, it does insure the performance of your Heathkit anywhere in the world — for most any other reason.

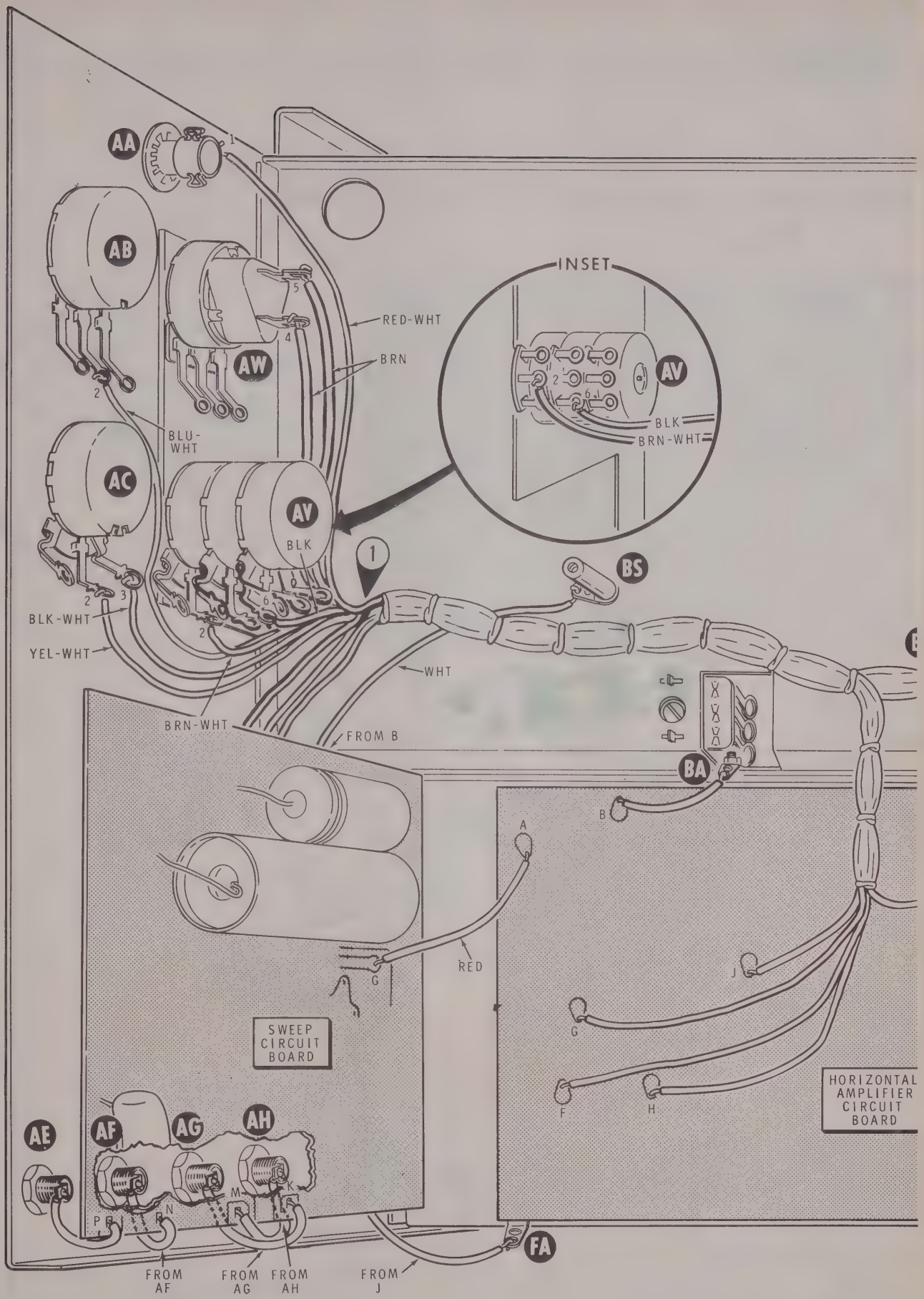
After-Warranty Service

What happens after warranty? We won't let you down. If your Heathkit needs repairs or you need a part, just write or call the factory, your nearest retail Heathkit Electronic Center, or any Heath authorized overseas distributor. We maintain an inventory of replacement parts for each Heathkit model at most locations — even for models that no longer appear in our current product line-up. Repair service and technical consultation is available through all locations.

We hope you'll never need our repair or replacement services, but it's nice to know you're protected anyway — and that cheerful help is nearby.

Sincerely,

HEATH COMPANY
Benton Harbor, Michigan 49022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HORIZONTAL AMPLIFIER CIRCUIT BOARD
FROM AF
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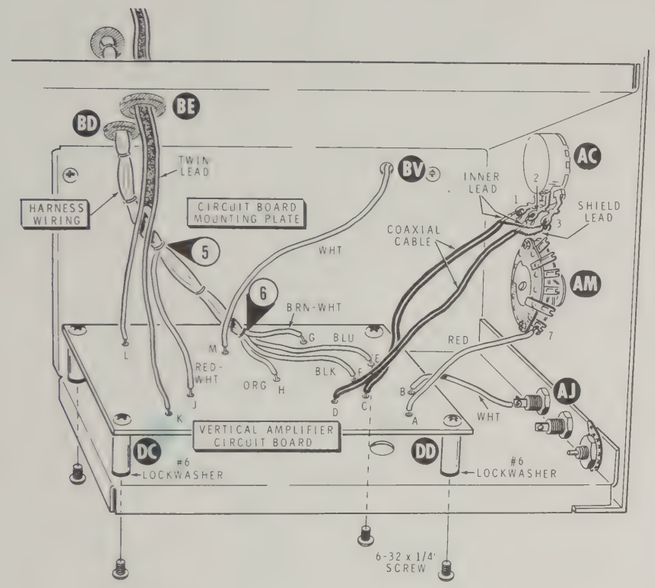
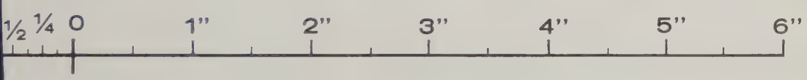
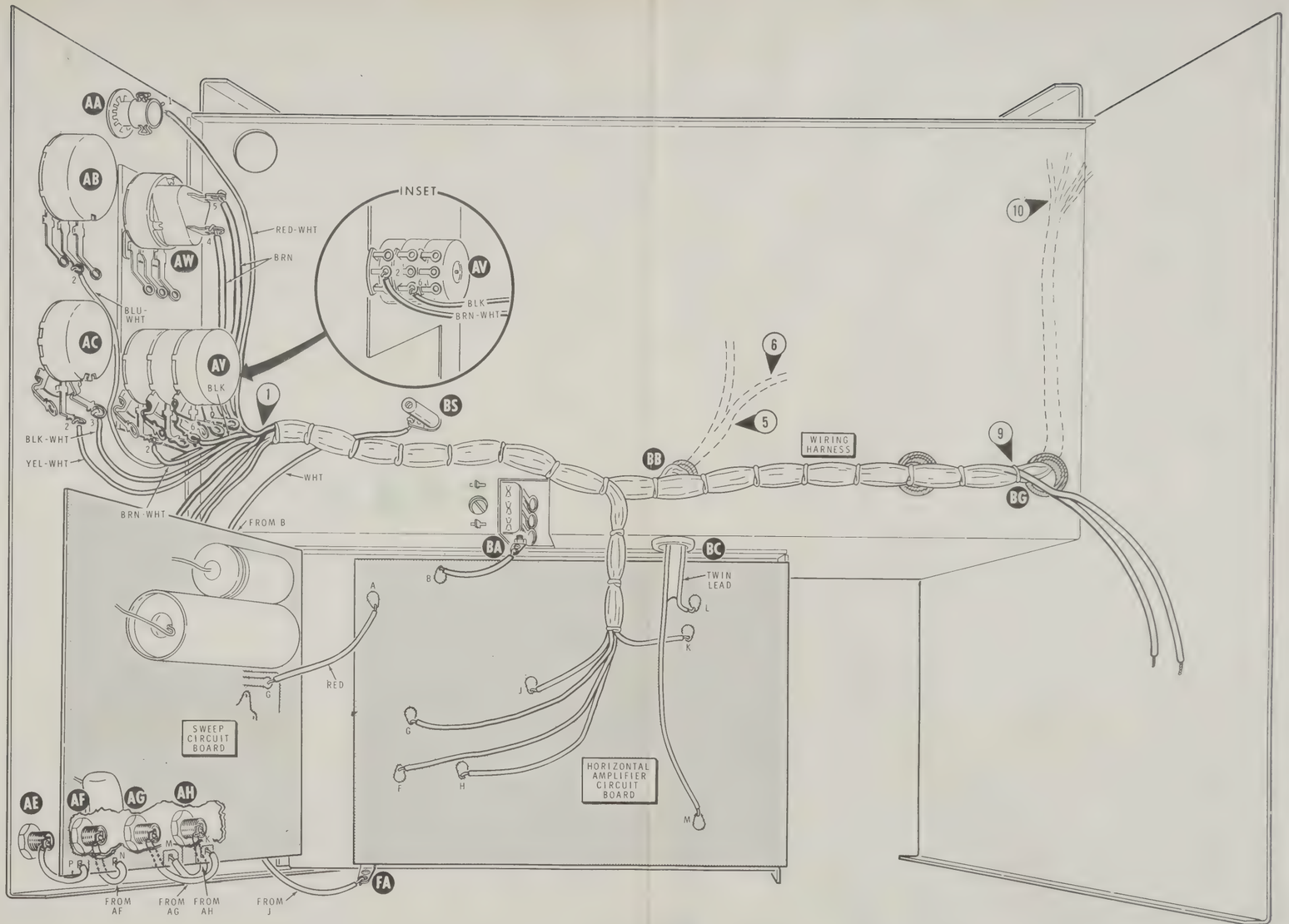


PICTORIAL 5-8





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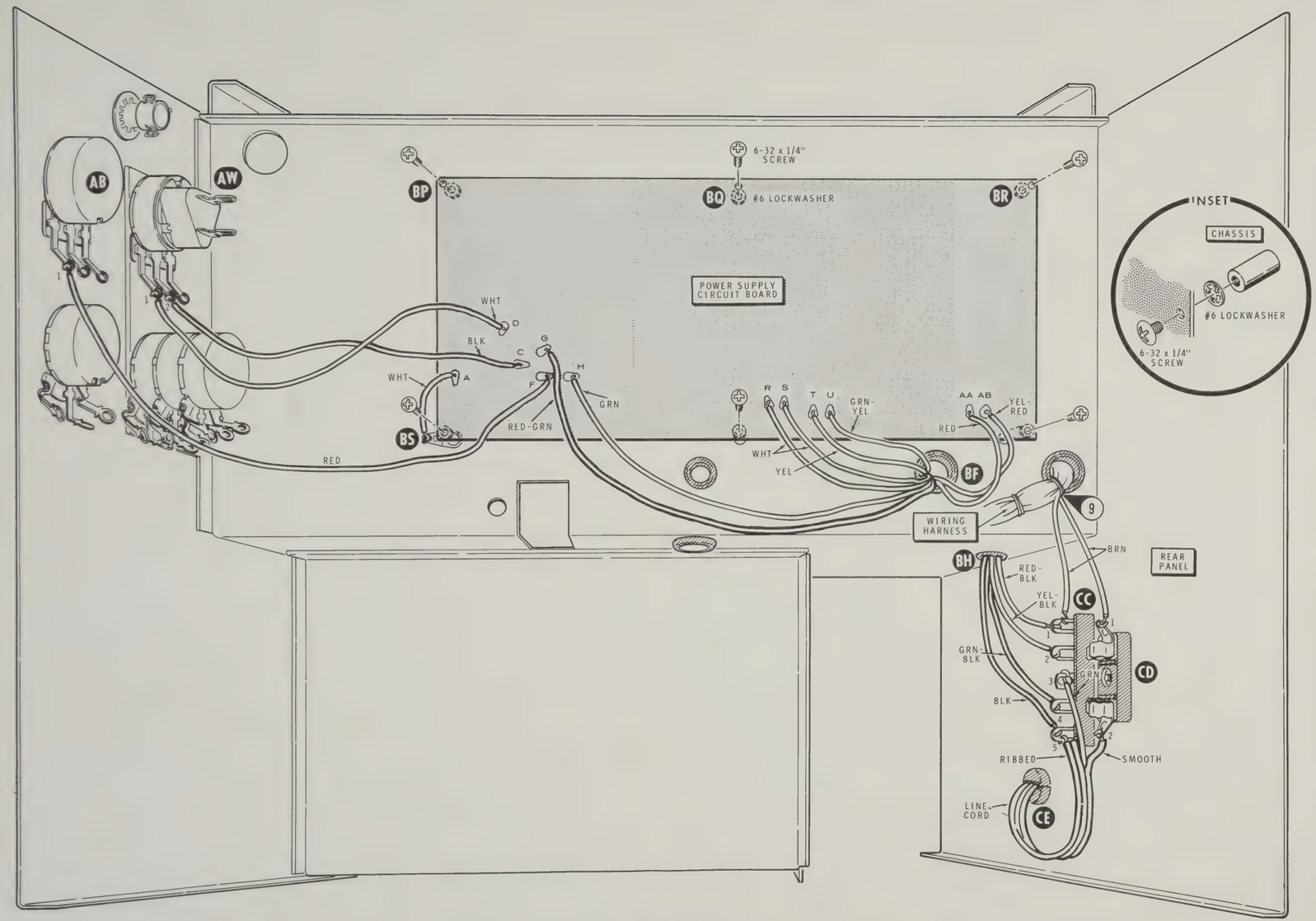

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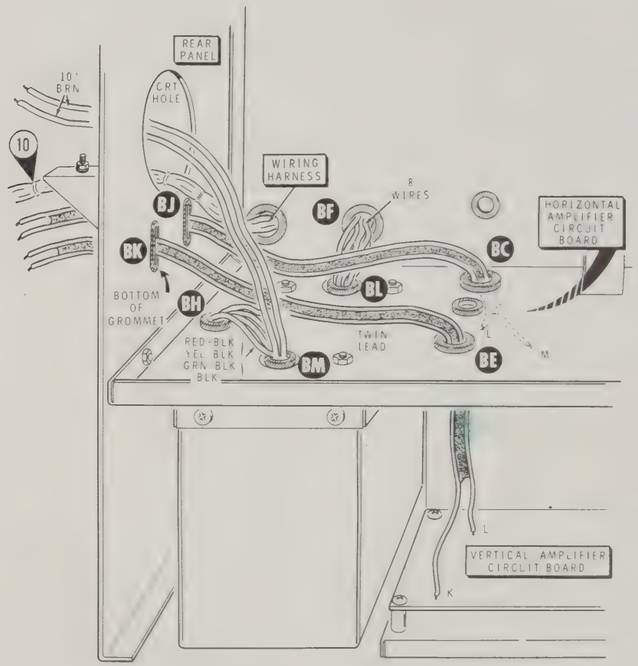

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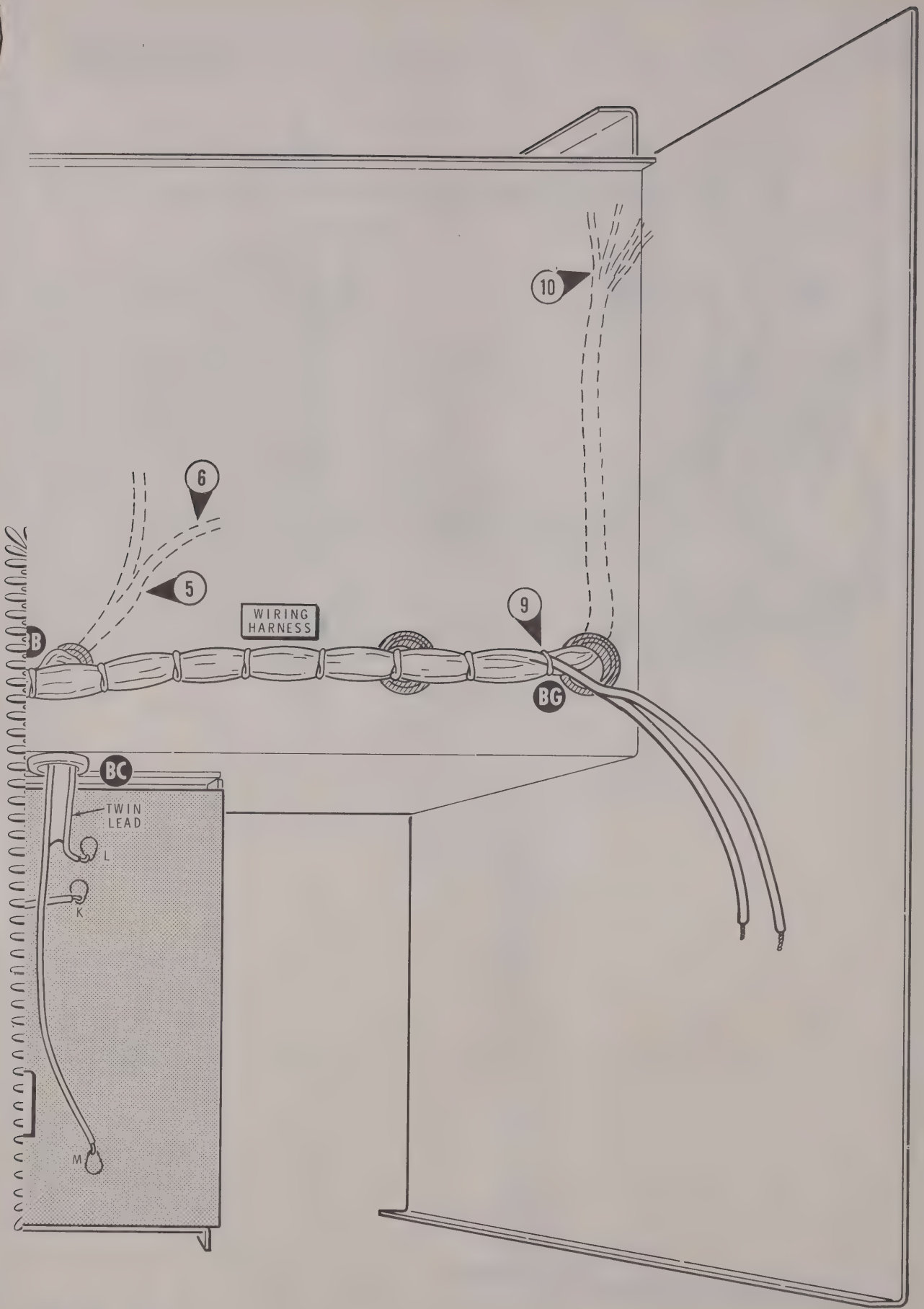

ORIAL 5-7

HEATH COMPANY

HEATHKIT

HEATH COMPANY

Phone 616-983-3961 • TWX-616-983-3897 • Benton Harbor, Michigan 49022

November 8, 1971

Dear Customer:

Please make the following changes in your Manual before you start to assemble your Oscilloscope.

Page 61 – Right column, first step, last line.

Change: VERT 100 V ADJUST: Fully counterclockwise
To: VERT 100 V ADJUST: Center of rotation

Pages 62 and 63 – Replace portions of these pages by taping the new sections, attached to this letter, over the corresponding places in your Manual.

Page 64 – Right column. Add the following note below "Figure 5."

NOTE: Depending on the risetime of your signal generator, you may or may not see the vertical portion(s) of your square wave(s).

Page 99 – Refer to the Schematic on the fold-out from this page. Locate point [E] at the top of the power supply circuit board.

Change the color callout of the lead coming from E from "RED" to WHT.

– Locate pin 2 on the Cathode Ray Tube V1. To the left of pin, above the words "TO A ON SWEEP BOARD,"

Add: RED

Thank you,

HEATH COMPANY

IO-102/595-1285-02
591-922

HEATH COMPANY

BENTON HARBOR, MICHIGAN

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

IN U.S.A.